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THIRTY-NINTH ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

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1908.

Approved by

The State Board of Publication.

MEMBERS OF THE BOARD.

1907.

HENRY P. WALCOTT, M.D., *Chairman*,	OF CAMBRIDGE.
JULIAN A. MEAD, M.D.,	OF WATERTOWN.
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GERARD C. TOBEY, ESQ.,	OF WAREHAM.
JAMES W. HULL,	OF PITTSFIELD.
HON. CHARLES H. PORTER,	OF QUINCY.
ROBERT W. LOVETT, M.D.,	OF BOSTON.

Secretary.

CHARLES HARRINGTON,[2] M.D.

Assistant to the Secretary.

WILLIAM C. HANSON, M.D.

Engineer.

X. H. GOODNOUGH, C.E.

Pathologist.

THEOBALD SMITH, M.D.

Analyst of Food and Drugs.

ALBERT E. LEACH, S.B.[3]
HERMANN C. LYTHGOE, S.B.

Chemist.

H. W. CLARK.

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[1] Resigned Aug. 28, 1907.

[2] Died Sept. 11, 1908.

[3] Resigned July 5, 1907.

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While this report was in press, Dr. Charles Harrington, secretary of the State Board of Health, died suddenly, in the prime of life, at Lynton, England, on September 11, in the fifty-third year of his age.

For four years he was the secretary and executive officer of the Board. He brought to it ample knowledge, ability and industry. His education had been carried on with especial regard to the branch of medicine to which his life was devoted. He was an original and accurate investigator of sanitary questions, a clear thinker and a courageous administrator, and always a much-loved associate.

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GENERAL REPORT.

In accordance with the provisions of chapter 211 of the Acts of 1905, the following report of the work of the several departments of the State Board of Health is presented for the fiscal year ended Nov. 30, 1907, on which date the Board was constituted as follows: Dr. John W. Bartol of Boston, whose resignation, after five years' faithful service, was presented in August, 1907, having been succeeded by Dr. Robert W. Lovett of Boston: —

Henry P. Walcott, M.D., of Cambridge, *Chairman.*

Julian A. Mead, M.D., of Watertown.
Hiram F. Mills, A.M., C.E., of Lowell
Robert W. Lovett, M.D , of Boston.
Gerard C. Tobey, Esq., of Wareham
James W. Hull, of Pittsfield.
Hon. Charles H. Porter, of Quincy.

During the legislative session of 1907, the most important act which was passed pertaining to the duties of the Board was chapter 537, which follows: —

Chapter 537.

An Act to provide for the Establishment of Health Districts and the Appointment of Inspectors of Health.

Be it enacted, etc., as follows:

Section 1. The state board of health shall. as soon as may be after the passage of this act, divide the Commonwealth into not more than fifteen districts, to be known as health districts, in such manner as it may deem necessary or proper for carrying out the purposes of this act.

Section 2. After the division aforesaid has been made, the governor, with the advice and consent of the council, shall appoint in each health district one practical and discreet person, learned in the science of medicine and hygiene, to be state inspector of health in that district. Every nomination for such office shall be made at least seven days prior to the appointment. The said state inspectors of health shall hold their offices for a period of five years from the time of their respective appointments, but shall be liable to removal from office by the governor and council at any time.

Section 3. Every state inspector of health shall inform himself respecting the sanitary condition of his district and concerning all influences dangerous to the public health or threatening to affect the same; he shall gather all information possible concerning the prevalence of tuberculosis and other diseases dangerous to the public health within his district. shall disseminate knowledge as to the best methods of preventing the spread of such diseases, and shall take such steps as, after consultation with the state board of health and the local state[1] authorities, shall be deemed advisable for their eradication; he shall inform himself concerning the health of all minors employed in factories within his district, and, whenever he may deem it advisable or necessary, he shall call the ill health or physical unfitness of any minor to the attention of his or her parents or employers and of the state board of health.

SECTION 4. The state inspectors of health shall be under the general supervision of the state board of health and shall perform such duties other than those hereby imposed upon them as the said board from time to time shall determine. They shall keep a record of their proceedings and observations, shall annually make a report of the same to said board on or before the thirty-first day of October, shall from time to time furnish said board with such information as it may require touching circumstances affecting the public health in their respective districts, and shall in every instance where written suggestions are made by them to the local authorities send copies of such suggestions to said board.

SECTION 5. The state inspectors of health shall, under the direction of the state board of health and in place of the inspection department of the district police, enforce the provisions of section forty-one of chapter one hundred and four of the Revised Laws so far as said section provides that factories shall be well ventilated and kept clean, sections forty-one, forty-four and forty-seven to sixty-one, inclusive, of chapter one hundred and six of the Revised Laws, chapter three hundred and twenty-two of the acts of the year nineteen hundred and two, chapter four hundred and seventy-five of the acts of the year nineteen hundred and three, chapter two hundred and thirty-eight of the acts of the year nineteen hundred and five, and chapter two hundred and fifty of the acts of the year nineteen hundred and six; and the powers and duties heretofore conferred and imposed upon the members of said inspection department of the district police by section eight of chapter one hundred and eight of the Revised Laws in respect to the foregoing sections and acts, and in respect to all acts in amendment thereof or in addition thereto, and in respect to any other laws, are hereby conferred and imposed upon said state inspectors of health or such other officers as the state board of health may from time to time appoint: *provided, however,* that neither said board of health nor any inspector thereof shall have authority to require structural alterations to be made in buildings, but shall report the necessity therefor to the inspection department of the district police. Wherever in said provisions of law the words "inspector" or "inspectors of factories and public buildings", "inspection department of the district police", "inspector" or "inspectors of the district police", "district police", "factory inspector" or "inspectors", and "member" or "members of the district police" occur, they shall be taken to mean state inspector or inspectors of health. Wherever the words "chief of the district police" occur, they shall be taken to mean the state board of health.

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[1] This is the phraseology of the bill as enacted. In its original form the expression used was "local health authorities" (House Bill 1408), but in its next form the word *state* was substituted, probably through inadvertence.

SECTION 6. The governor, with the advice and consent of the council, shall establish the salaries of said state inspectors of health, having regard in each district to the extent of territory, the number of inhabitants, the character of the business there carried on, and the amount of time likely to be required for the proper discharge of the duties. The salaries thus established shall be paid from the treasury of the Commonwealth monthly.

SECTION 7. There may be expended out of the treasury of the Commonwealth annually, for the purposes specified in this act, for salaries, a sum not exceeding twenty-five thousand dollars, and for other expenses, a sum not exceeding five thousand dollars.

SECTION 8. For the purpose of carrying out the provisions of this act the state board of health may employ from time to time experts in sanitation.

SECTION 9. This act shall take effect upon its passage. [*Approved June 19, 1907.*

In accordance with the provisions of section 1 of this act the Board, on July 9, divided the Commonwealth into fifteen districts, as follows: —

Health District No. 1. — The counties of Barnstable, Dukes and Nantucket, and the town of Wareham.

Health District No. 2. — The cities of Fall River and New Bedford, and the towns of Acushnet, Berkley, Dartmouth, Dighton, Fairhaven, Freetown, Marion, Mattapoisett, Rehoboth, Rochester, Seekonk, Somerset, Swansea and Westport.

Health District No. 3. — Plymouth County, exclusive of the towns of Marion, Mattapoisett, Rochester and Wareham, and, in addition, the towns of Cohasset and Weymouth.

Health District No. 4. — The cities of Quincy and Taunton, and the towns of Attleborough, Avon, Bellingham, Blackstone, Braintree, Canton, Dedham, Easton, Foxborough, Franklin, Holbrook, Hyde Park, Mansfield, Milton, Norfolk, Norton, North Attleborough, Norwood, Plainville, Randolph, Raynham, Sharon, Stoughton, Walpole, Westwood and Wrentham.

Health District No. 5. — Suffolk County.

Health District No. 6. — The cities of Cambridge, Everett, Malden, Medford, Melrose and Somerville, and the towns of North Reading, Reading, Stoneham and Wakefield.

Health District No. 7. — The cities of Beverly, Gloucester, Lynn and Salem, and the towns of Danvers, Essex, Ipswich, Hamilton, Lynnfield, Manchester, Marblehead, Middleton, Nahant, Peabody, Rockport, Saugus, Swampscott, Topsfield and Wenham.

Health District No. 8. — The cities of Haverhill, Lawrence and Newburyport, and the towns of Amesbury, Andover, Boxford, Georgetown, Groveland, Merrimac, Methuen, Newbury, North Andover, Rowley, Salisbury and West Newbury.

Health District No. 9. — The cities of Lowell and Woburn, and the towns of Acton, Arlington, Ayer, Bedford, Billerica, Boxborough, Burlington, Carlisle, Chelmsford, Concord, Dracut, Dunstable, Groton, Harvard, Lexington, Lincoln, Littleton, Maynard, Pepperell, Shirley, Stow, Tewksbury, Townsend, Tyngsborough, Westford, Wilmington and Winchester.

Health District No. 10. — The cities of Marlborough, Newton and Waltham, and the towns of Ashland, Belmont, Brookline, Dover, Framingham, Grafton, Holliston, Hopedale, Hopkinton, Hudson, Medfield, Medway, Mendon, Milford, Millis, Natick, Needham, Northborough, Sherborn, Shrewsbury, Southborough, Sudbury, Upton, Watertown, Wayland, Wellesley, Westborough and Weston.

Health District No. 11. — The city of Worcester, and the towns of Auburn, Brookfield, Charlton, Douglas, Dudley, Leicester, Millbury, Northbridge, North Brookfield, Oxford, Southbridge, Spencer, Sturbridge, Sutton, Uxbridge, Warren, Webster and West Brookfield.

Health District No. 12. — The city of Fitchburg, and the towns of Ashburnham, Ashby, Athol, Barre, Berlin, Bolton, Boylston, Clinton, Dana, Gardner, Hardwick, Holden, Hubbardston, Lancaster, Leominster, Lunenburg, New Braintree, Oakham, Paxton, Petersham, Phillipston, Princeton, Royalston, Rutland, Sterling, Templeton, Westminster, Winchendon and West Boylston.

Health District No. 13. — Franklin County, and all of Hampshire County excepting the towns of Huntington, Middlefield and Worthington.

Health District No. 14. — Hampden County, and, in addition, the towns of Huntington, Middlefield and Worthington.

Health District No. 15. — Berkshire County.

On the tenth day of July, 1907, the following were appointed by the Governor to be State inspectors of health: —

District No. 1. — Dr. Charles G. Morse, Wareham.

District No. 2. — Dr. Adam G. MacKnight, 355 North Main Street, Fall River.

District No. 3. — Dr. Wallace C. Keith, 237 North Main Street, Brockton.

District No. 4. — Dr. Elliott Washburn, 50 Broadway, Taunton.

District No. 5. — Dr. Harry Linenthal, 327 Blue Hill Avenue, Boston.

District No. 6. — Dr. Albert P. Norris, 728 Massachusetts Avenue, Cambridge.

District No. 7. — Dr. J. William Voss, 108 Cabot Street, Beverly.

District No. 8. — Dr. William Hall Coon, 70 Newbury Street, Lawrence.

District No. 9. — Dr. Charles E. Simpson, Lowell Hospital, Lowell.

District No. 10. — Dr. William W. Walcott, 32 West Central Street, Natick.

District No. 11. — Dr. Melvin G. Overlock, 91 Chandler Street, Worcester.

District No. 12. — Dr. Lewis Fish, 7 Highland Avenue, Fitchburg.

District No. 13. — Dr. Harvey T. Shores, 177 Elm Street, Northampton.

District No. 14. — Dr. Richard S. Benner, 10 Chestnut Street, Springfield. Resigned in October and was succeeded by Dr. Herbert C. Emerson of Springfield.

District No. 15. — Dr. Lyman A. Jones, 170 Main Street, North Adams.

Under the rules, consideration was postponed until July 17, when the appointments were severally confirmed by the Council.

Summaries of the reports called for by section 4 are presented in the Supplement.

Diseases Dangerous to the Public Health.

Prior to the legislative session of 1907, the expression "diseases dangerous to the public health," which appears in several sections of chapter 75 of the Revised Laws and of later acts, was nowhere defined, and in consequence a very wide latitude was allowed to householders and medical practitioners in reporting cases of infective diseases to local boards of health, and to local boards in reporting the same to the State Board of Health; and much confusion and dispute arose between different communities in the adjustment of claims presented under chapter 213 of the Acts of 1902. The Legislature of 1907 passed two important amending acts, which leave no discretion to individuals and local authorities in defining the term, and prevent further disputes and litigation.

The first of these has reference to the term as it is used in chapter 213 of the Acts of 1902. It is as follows: —

Chapter 183.

An Act to authorize the State Board of Health to define what Diseases are to be deemed Dangerous to the Public Health.

Be it enacted, etc., as follows:

Section 1. The state board of health is hereby authorized and directed to define what diseases shall be deemed to be "dangerous to the public health," as the term is used in chapter two hundred and thirteen of the acts of the year nineteen hundred and two.

Section 2. This act shall take effect upon its passage. [*Approved March 8, 1907.*

At a meeting of the Board, held on Aug. 1, 1907, the following diseases were classed as "dangerous to the public health" within the meaning of the said chapter: —

Actinomycosis.
Asiatic cholera.
Cerebro-spinal meningitis.
Diphtheria.
Glanders.
Leprosy.
Malignant pustule.
Measles.
Scarlet fever.
Smallpox.
Tuberculosis.
Typhoid fever.
Typhus fever.
Whooping cough.
Yellow fever.

The second (chapter 480) has reference to the compulsory notification and registration of tuberculosis and other diseases dangerous to the public health, and amends sections 49, 50 and 52 of chapter 75 of the Revised Laws by inserting after the word "disease," wherever it occurs, the words "declared by the state board of health to be" (dangerous, etc.). The sections so amended read now as follows: —

> SECTION 49. A householder who knows that a person in his family or house is sick of smallpox, diphtheria, scarlet fever or any other infectious or contagious disease declared by the state board of health to be dangerous to the public health shall forthwith give notice thereof to the board of health of the city or town in which he dwells. Upon the death, recovery or removal of such person, the householder shall disinfect to the satisfaction of the board such rooms of his house and articles therein as, in the opinion of the board, have been exposed to infection or contagion. Should one or both eyes of an infant become inflamed, swollen and red, and show an unnatural discharge at any time within two weeks after its birth, it shall be the duty of the nurse, relative or other attendant having charge of such infant to report in writing within six hours thereafter, to the board of health of a city or town in which the parents of the infant reside, the fact that such inflammation, swelling and redness of the eyes and unnatural discharge exist. On receipt of such report, or of notice of the same symptoms given by a physician as provided by the following section, the board of health shall take such immediate action as it may deem necessary in order that blindness may be prevented. Whoever violates the provisions of this section shall be punished by a fine of not more than one hundred dollars.
>
> SECTION 50. If a physician knows that a person whom he is called to visit is infected with smallpox, diphtheria, scarlet fever or any other disease declared by the state board of health to be dangerous to the public health, or if one or both eyes of an infant whom or whose mother he is called to visit become inflamed, swollen and red, and show an unnatural discharge within two weeks after the birth of such infant, he shall immediately give notice thereof in writing over his own signature to the selectmen or board of health of the town; and if he refuses or neglects to give such notice, he shall forfeit not less than fifty nor more than two hundred dollars for each offence.
>
> SECTION 52. If the board of health of a city or town has had notice of a case of smallpox, diphtheria, scarlet fever or of any other disease declared by the state board of health to be dangerous to the public health therein, it shall within twenty-four hours thereafter give notice thereof to the state board of health stating the name and the location of the patient so afflicted, and the secretary thereof shall forthwith transmit a copy of such notice to the state board of charity.

At a meeting of the State Board of Health, held Aug. 1, 1907, the following diseases were declared to be "dangerous to the public health," and hence notifiable under the provisions of the above sections: —

Actinomycosis.
Asiatic cholera.
Cerebro-spinal meningitis.
Diphtheria.
Glanders.
Leprosy.
Malignant pustule.
Measles.
Scarlet fever.
Smallpox.
Tetanus.
Trichinosis.
Tuberculosis.
Typhoid fever.
Typhus fever.
Varicella.
Whooping cough.
Yellow fever.

Pollution of Boston Harbor.

On March 11, 1907, the Legislature passed the following order: —

> *Ordered,* That the State Board of Health is hereby directed, from information in its possession or which it may readily obtain, to report to the next General Court, not later than January 15, as to the best means of preventing the further pollution of Boston harbor by the discharge of foul sewage at Moon Island.

The report called for follows: —

The sewage discharged at the Moon Island outlet is that which is collected by the main drainage system of the city of Boston. In character it is not essentially different from that of other cities, except for a slight admixture of salt water which leaks into the sewers located near the shores of the harbor and its estuaries, through tide gates and in other ways. It becomes somewhat decomposed in its passage through the deposit sewers, the tunnel, and especially the reservoirs at Moon Island, in which it is stored for several hours in order to admit of its discharge only in the second and third hours of the outgoing tide, when the currents are most favorable for its speedy removal and dilution with a large volume of sea water; but at the time of its discharge it is not noticeably more offensive than the sewage of other cities and towns stored in reservoirs for convenience in disposal.

The Boston main drainage works were completed and the outlet at Moon Island first used in 1884. The quantity of sewage discharged there gradually increased for many years, owing to the growth of the city and the extension of sewers into metropolitan areas adjacent thereto, chiefly in the Charles and Neponset River valleys. The quantity of sewage delivered at Moon Island eventually became so great that the reservoir capacity became unequal to the storage of all of the sewage for a sufficient length of time to allow for its discharge in the two most favorable hours of the outgoing tide; but in 1899 the capacity of the reservoirs was doubled, and the necessity for discharging considerable quantities of sewage at unfavorable times was removed. In 1904 the quantity of sewage delivered at this outlet was greatly reduced by the completion of the high-level sewer and the diversion of all of the sewage of the Charles and Neponset River valleys into the high-level system, which has a separate outlet at Peddocks Island. In subsequent years the sewage of other considerable areas has been connected with the high-level system, and, while no satisfactory records of the quantity of sewage discharged at Moon Island are available, the quantity discharged at Peddocks Island — all of which has been diverted from the Moon Island outlet within the past three years — amounted during the year 1906 to 33,600,000 gallons per day. It is probable that the quantity of sewage discharged at Moon Island at the present time is considerably less than 100,000,000 gallons per day.

In the summer of 1905, after the quantity of sewage discharged at Moon Island had been reduced by the diversion of the sewage of the Charles and Neponset River valleys into the high-level system, an investigation was made by this Board to determine the condition of the water of Boston harbor and the effect of the discharge of sewage therein. This investigation showed that the quantity of free ammonia present in the waters of the inner harbor — *i.e.,* inside or west of a line drawn from the easterly end of East Boston to South Boston — was greater on the outgoing tide than anywhere in the region of the harbor about Moon Island, excepting in the narrow path taken by the sewage in passing from Moon Island to the sea and within two and one-half miles of Moon Island. On the incoming tide the quantity of free ammonia found in the water of the inner harbor was greater than was found anywhere in the region about Moon Island, excepting immediately about the sewer outlet itself.

The same is true of the results of bacterial examinations. On the outgoing tide the number of bacteria was higher in the inner harbor than anywhere about Moon Island, excepting in the immediate track of the sewage and within two and one-half miles of the outlet. On the incoming tide the number of bacteria was greater in the inner harbor than anywhere in the neighborhood of Moon Island, excepting immediately about the outlet.

Other examinations were made to determine more definitely the area affected by the discharge of sewage at the Moon Island outlet, and samples of water were collected for analysis from numerous stations for a long distance about this outlet. The results confirm those of the previous investigations, showing that the effect of the sewage discharged at the Moon Island outlet upon the harbor water is markedly noticeable only in a restricted area extending from the outlet along the path taken by the sewage toward the sea, and that outside of this area, which at its greatest extension does not exceed two and one-half miles in length by one-half to three-quarters of a mile in width, and then only during the outgoing tide, — the period when the sewage is discharged, — is the water noticeably more polluted, as shown by chemical or bacterial analysis, than the water in the inner harbor.

An examination of the outlet at Moon Island in August, 1907, and observations of the discharge of sewage there, indicate that the works at that point are well cared for, and the times of discharge strictly adhered to by the officer in charge of that work.

While the order of the Legislature does not appear to have been intended to include the main sewer outlets at Deer Island and at Peddocks Island, the Board would add that the sewage from those outlets — which is discharged in smaller quantities and also continuously at all stages of the tide, and hence in a very much smaller volume than at Moon Island — has a much less noticeable effect upon the harbor water than that discharged at Moon Island during the few hours immediately after it is discharged there.

In view of the fact that the waters of the inner harbor of Boston show more evidence of pollution than the waters of the outer harbor, excepting in the neighborhood of the main sewer outlets and in the immediate track of the sewage from Moon Island after it has been discharged and is on its way to sea, and in view of the results of observations of the Board showing that the pollution of the inner harbor is not due to the discharge of sewage at Moon Island or at either of the other main outlets, the Board sees no present necessity for the adoption of means for the prevention of the further pollution of the harbor by the discharge of sewage at Moon Island or at either of the other main outlets.

Establishment and Enlargement of Cemeteries.

On March 26, 1907, the Legislature passed the following order: —

Ordered, That the State Board of Health be directed to make an investigation of the conditions under which new cemeteries should be established and old cemeteries enlarged, and report to the next General Court not later than January 15 the result of such investigation, together with such recommendations as said Board may deem advisable.

The report called for follows: —

The investigation has been made from the material already in the possession of the Board, and by means of special reports made by the State inspectors of health in the fifteen health districts of the State.

The existing statutes (chapter 78, section 30) provide that no land shall be used for the purpose of burial unless by permission of the town or of the mayor and aldermen of the city in which the land lies. The statutes also provide (chapter 78, section 31) that boards of health may make regulations concerning burial grounds and interments within their cities and towns. These statutes at present control the establishment of new cemeteries and the extension of old ones.

It seems to the Board important that the location of cemeteries where they may affect public water supplies should be controlled, and it has been the custom of the Board in making rules and regulations for the sanitary protection of public water supplies to provide a rule that no lands, not under the control of cemetery authorities and used for cemetery purposes, at the time rules are made for the sanitary protection of a public water supply, shall be used for such purposes within the watershed of that source except with the written approval of the State Board of Health. While many cities and towns have availed themselves of these rules, a much larger number have not yet done so, and are consequently without protection from the location of new cemeteries or the extension of old ones within the watersheds of their sources of supply.

It appears to the Board desirable that such protection should be provided by statute.

The provisions of existing laws appear to the Board inadequate for the protection of the public against the location of a cemetery in an objectionable place, especially in places where, while unobjectionable to the inhabitants of the city or town in which it was located, it might be injurious to inhabitants of an adjoining city or town: and the Board would advise that provision be made for an appeal, in questions of the location or extension of cemeteries, from the action of the city or town to the State Board of Health.

An examination of the statutes relating to cemeteries in other States of the United States and in foreign countries shows that in many of these there are regulations specifying definite distances from dwelling houses within which, without consent of the owner, no cemetery or extension of a cemetery shall be located. No such provision is found in the statutes of Massachusetts, and, in the opinion of the Board, it is reasonable and desirable to provide such a limit. In the States of this country having such regulations the distance varies from about 200 feet to more than half a mile, the average of those not excessively great being 400 feet. In England the prescribed limit is 300 feet. The limit of 300 feet is not an unreasonable one for the conditions found in Massachusetts, and the Board recommends that such legislation be made.

Water Supply and Sewerage.

The Board received during the year 124 applications for advice with reference to water supply, sewerage, sewage disposal and matters relating thereto. Of these applications, 87 were in relation to water supply, 8 to sources of ice supply, 24 to sewerage, drainage and sewage-disposal systems, and 5 to miscellaneous matters.

Examination of Water Supplies.

A public water supply was introduced during the year in the town of Chelmsford, and at the end of the year 185 of the 354 cities and towns in the State were provided with public water supplies. All of the cities and towns having a population, according to the census of 1905, in excess of 3,500, are now provided with public water supplies, except the towns of Barnstable, Blackstone, Dartmouth, Dudley, Templeton and Tewksbury. The cities and towns having public water supplies contain approximately 93 per cent. of the total population of the State.

The usual chemical and microscopical analyses of the waters of public water supplies have been continued, and bacterial examinations have been made of many of the ground waters. The total number of sources examined during the year was 278, many of which were inspected by the engineer of the Board or his assistants.

In previous reports attention has been called to the objectionable condition of the water supplies of Franklin and Great Barrington. The town of Franklin has recently acquired the property, franchises, etc., of the Franklin Water Company, has completed works for the introduction of water from wells west of Beaver Pond, and has discontinued the use of the objectionable sources from which the supply of the town had previously been drawn. The town of Great Barrington continues to use Green River as its principal source of water supply, notwithstanding the fact that the stream and its tributaries are exposed greatly to pollution from the population on its watershed, and the danger of injury to health involved in these conditions.

Water Supply of Lynn.

By the provisions of chapter 509 of the Acts of the year 1906 the State Board of Health and the water board of the city of Lynn were authorized and directed to investigate plans for enlarging and improving the water supply of that city, and the results of this investigation were presented to the Legislature of 1907. The following act was then passed, authorizing the city to enlarge and improve its water supply and make an additional water loan: —

Acts of 1907, Chapter 479.

An Act to authorize the City of Lynn to enlarge and improve its Water Supply and to make an Additional Water Loan.

Be it enacted, etc., as follows:

Section 1. The city of Lynn, for the purpose of enlarging and improving its water supply, is hereby authorized to issue from time to time bonds, notes or scrip, to be denominated on the face thereof, Lynn Water Loan, Act of 1907, to an amount not exceeding three hundred thousand dollars in addition to the amounts heretofore authorized by law to be issued by said city for similar purposes, which shall be payable at the expiration of periods not exceeding thirty years from the dates of issue, shall bear interest payable semi-annually at a rate not exceeding four per cent per annum, and shall be signed by the treasurer and countersigned by the board of water commissioners and by the mayor of the city. The city may sell such securities at public or private sale, or pledge the same for money borrowed for the purposes of this act, upon such terms and conditions as it may deem proper, provided that they shall not be sold for less than the par value thereof.

Section 2. The said city shall, at the time of authorizing said loan, provide for the payment thereof in such annual proportionate payments as will extinguish the same within the time prescribed by this act; and when a vote to that effect has been passed the amount required thereby shall without further vote be assessed by the assessors of the city in each year thereafter in the same manner in which other taxes are assessed until the debt incurred by the loan is extinguished. The city shall also raise annually by taxation a sum which, with the income derived from water rates, will be sufficient to pay the interest as it accrues on the securities issued under authority hereof.

SECTION 3. The proceeds of the sale or pledge of the said securities shall be used for necessary expenditures in connection with the enlargement and development of the water supply system of the city, and for the protection and improvement of the quality of the water; and the city may take, or acquire by purchase or otherwise, and hold for said purposes, any lands, easements or rights of way necessary for the purposes of this act, and for the purposes aforesaid may erect on any lands purchased, taken or held, proper dams, reservoirs, buildings, conduits, pipes, fixtures, filters or other structures necessary for the said purposes: *provided, however,* that no lands or rights therein shall be purchased, taken or used under this act without the consent of the state board of health, given after notice and a public hearing. In carrying out the provisions of this act the city of Lynn shall have the authority and be subject to all the duties, restrictions and liabilities set forth in chapter two hundred and eighteen of the acts of the year eighteen hundred and seventy-one and acts in amendment thereof or addition thereto.

SECTION 4. The construction of the works necessary for the enlargement and development of the said water supply and for protecting and improving the quality of the water shall be begun by said city, acting through its public water board, within one year, and shall be completed within three years after the passage of this act. The said works shall provide an adequate quantity of good water for all the requirements of the city, for the proper sanitary protection of such water and for the elimination and diversion from the sources of supply of all polluted waters, or for their purification or treatment, in such manner as will fully protect the public health.

SECTION 5. The construction of the said works shall be carried out by the public water board of said city, and the board is hereby further authorized and directed to make all necessary preliminary investigations and to prepare plans for the works, and for this purpose shall have power to employ engineering experts as to the sanitary protection, storage and purification of water, and such other assistance as may be necessary. The preliminary investigations herein authorized shall include: an estimate of the cost of cleansing and making sanitary the watersheds of Pillings pond and Beaver Dam brook, so-called, in the town of Lynnfield, and of the cost of connecting the same with the present sources of water supply, together with an estimate of the amount of increase in the supply of water obtainable by the use of said pond and brook; an estimate of the cost of a conduit or pipe line to convey water from the Ipswich river or Martin's brook either separately or in connection with the water of Pillings pond and Beaver Dam brook into the present reservoirs of the city of Lynn, or for pumping water either from said Ipswich river or said Martin's brook into said Pillings pond or the present reservoirs by the plan deemed by said board to be most advisable; an estimate of the cost of cleaning or covering the bottom of Walden pond and of other ponds now used by the city of Lynn, or such parts of the bottom of Walden pond or the other ponds as have not so been treated;

an investigation of the quality of the waters of all of the various sources and tributaries now used or available for the use of said city, with chemical and bacterial examinations thereof, at such points as may be agreed upon by the engineers and experts employed by the Lynn water board and the state board of health, including an investigation of all sources and causes of pollution or objection affecting the present or proposed sources of supply of the city of Lynn, the best methods of removing the same, and the estimated cost thereof.

SECTION 6. No act shall be done or liability incurred under this act in enlarging or improving the water supply of the city of Lynn, except in the making of surveys and investigations and the preparation of plans hereby authorized, until plans of the proposed conduits, reservoirs, pipe lines, except distribution pipes, filters or other works necessary to provide an adequate quantity of pure water for the city have been submitted to and approved by the state board of health; and the said plans shall be presented to said board for approval not later than December thirty-first, nineteen hundred and seven, and shall be acted upon by said board on or before the third Wednesday in January in the year nineteen hundred and eight.

SECTION 7. This act shall take effect upon its passage.

WATER SUPPLY OF LAWRENCE.

Early in the year 1906 a contract was made by the city of Lawrence for the construction of a covered sand filter, to increase the capacity of the works for filtering its water supply drawn from the Merrimack River. The new filter had not been completed at the end of the year, and early in January, 1907, the city applied to the neighboring towns of Andover and North Andover for emergency supplies from the works of each of those towns.

By the provisions of chapter 25, section 35, of the Revised Laws, as amended by chapter 361 of the Acts of the year 1902, the city council of a city or the selectmen or water commissioners of a town may purchase water from any city, town or water company for a period of not more than six months in any one year in such quantities as may be necessary to relieve an emergency, provided the State Board of Health approves the source of supply. The act also provides that the vote of a city council or the inhabitants of a town to make or authorize such purchase shall be conclusive evidence of the existence of the emergency.

The town of Andover, in response to the request from the city of Lawrence, voted, on Jan. 7, 1907, to grant an emergency supply of water to that city; and a connection with the mains of the town of Andover was completed on January 10, and water turned into the Lawrence mains on January 11. The pressure in the mains of the town of Andover is higher than in those of the city of Lawrence, but the quantity that would flow through the connection under the available head was not sufficient to provide all of the additional quantity of water required. The application of the city of Lawrence to the town of North Andover for an emergency supply from that town was submitted to a town meeting called for the purpose, and at this meeting the town voted to refuse the aid requested. The city then appealed to the Legislature for an act to enable it to secure such additional supply as could be provided without difficulty by the town of North Andover, and in response to this petition the Legislature passed the following act: —

ACTS OF 1907, CHAPTER 89.

AN ACT TO AUTHORIZE THE CITY OF LAWRENCE TO OBTAIN A TEMPORARY SUPPLY OF WATER FROM THE TOWN OF NORTH ANDOVER.

Be it enacted, etc., as follows:

SECTION 1. The city of Lawrence, for the purpose of obtaining a temporary additional supply of water, may extend its water pipes into the town of North Andover and may connect said pipes with the pipes of the North Andover water works at such point or points as may be approved by the water commissioners of said town. At the expiration of the time named in section two of this act all connection of the pipes of said town and city shall be discontinued.

SECTION 2. The town of North Andover, acting by its water commissioners or board of public works, is hereby authorized to take such quantity of water from the great pond in said town, in addition to the quantity which it is now authorized by law to take, as the state board of health may designate, and to supply the same daily to the city of Lawrence for a period not exceeding six months from the passage of this act; but nothing herein contained shall require said town to diminish the quantity of water required for its own daily needs or to furnish more to said city than its present pumps and machinery can furnish by reasonable use thereof.

SECTION 3. The city of Lawrence shall pay all damages that may be sustained by any person or corporation by the taking or supplying of water or by extending its pipes and making connections with the pipes of the North Andover water works, or by reason of any other act done by said city or said town under the authority of this act; and such damages shall be assessed and determined in the manner provided by chapter forty-eight of the Revised Laws, and any petition for such damages shall be filed within three years after the supply of water to said city under this act has ceased.

SECTION 4. The city of Lawrence shall pay to the town of North Andover for the water so obtained a sum which may mutually be agreed upon, or, in case of a disagreement as to the amount to be paid, the superior court for the county of Essex shall, upon petition, appoint one or more commissioners to hear the parties and to report to the court the facts, or the facts with evidence, which report when finally approved by the court shall be binding upon the parties. The compensation of said commissioner or commissioners shall be fixed by the court and paid in the same manner as are the fees of auditors appointed by the court.

SECTION 5. This act shall take effect upon its passage.

Upon the passage of this act a connection was made as quickly as possible with the mains of the town of North Andover, and water from the works of that town was turned into the Lawrence mains on Feb. 14, 1907. As in the case of Andover, the pressure in the North Andover mains is greater than in those of Lawrence.

By the use of the water secured from the towns of Andover and North Andover the city of Lawrence was enabled to secure enough water, in addition to the quantity that the filter would furnish, to supply all the requirements of the city during the winter, and the water from Andover was shut off on April 29 and that from North Andover on April 30, 1907. During the period while these sources were in use the total quantity of water supplied by Andover was 49,672,000 gallons and by North Andover 37,160,000 gallons, a total of 86,832,000 gallons, or an average of 797,000 gallons per day in the period from January 11, when water was first turned on from Andover, to April 30, when the supply from the towns was finally shut off.

The construction of the new filter was delayed by the falling of a portion of the roof early in the spring; but the work was finally completed and water turned on to the filter for the first time on Nov. 5, 1907. The new filter is adjacent to the old one on its up-stream side, is constructed at approximately the same level, and will be supplied with water by gravity from the same intake from the Merrimack River. The filter consists of a single chamber 312.6 feet long and 103.5 feet wide, and has a superficial area of about 32,000 square feet, or about three-quarters of an acre. Its capacity for purifying the water of the Merrimack River is about 1,600,000 gallons per day. The specifications for the filter call for sand of similar character to that in the old city filter, with provision for similar operation. The effluent from the filter will be discharged into the present pump well at the pumping station as soon as the filter reaches good working order.

RULES AND REGULATIONS FOR PREVENTING THE POLLUTION AND SECURING THE SANITARY PROTECTION OF WATERS USED AS SOURCES OF WATER SUPPLY.

In the last annual report the Board recommended the passage of an act authorizing it to delegate authority to grant or withhold permits for boating, fishing, ice cutting, etc., to local authorities, subject to its advice and regulation; and the Legislature subsequently passed an act (chapter 467 of the Acts of 1907) entitled, "An Act to authorize the state board of health to delegate certain authority to boards of health, water boards and water commissioners in cities and towns," by which section 113 of chapter 75 of the Revised Laws is amended, so that said section now reads as follows: —

> SECTION 113. Said board may cause examinations of such waters to be made to ascertain their purity and fitness for domestic use or their liability to impair the interests of the public or of persons lawfully using them or to imperil the public health. It may make rules and regulations to prevent the pollution and to secure the sanitary protection, of all such waters as are used as sources of water supply. Said board may delegate the granting and withholding of any permit required by such rules or regulations to state boards and commissions and to selectmen in towns and to boards of health, water boards and water commissioners in cities and towns, to be exercised by such selectmen, boards and commissions, subject to such recommendation and direction as shall be given from time to time by the state board of health; and upon complaint of any person interested said board shall investigate the granting or withholding of any such permit and make such orders relative thereto as it may deem necessary for the protection of the public health.

Under authority given by the statutes, the State Board of Health has at various times adopted rules and regulations for the protection of the water supplies of the following cities and towns: —

Abington and Rockland.
Amherst.
Attleborough.
Brockton and Whitman.
Cambridge.
Chicopee.
Danvers and Middleton.
Easthampton.
Fall River.
Falmouth.
Fitchburg.
Greenfield.
Haverhill.
Lincoln and Concord.
Lynn.
Marlborough.
Maynard.
Northampton.
Northborough.
Norwood.
Peabody.
Pittsfield.
Plymouth.
Randolph and Holbrook.
Rockport.
Salem and Beverly.
Springfield and Ludlow.
Taunton.
Wakefield.
Westfield.
West Springfield.
Weymouth.
Worcester.

After the passage of the law above quoted the Board voted to delegate the granting and withholding of any permit required by such rules and regulations to the authority in each of the above cities and towns having charge of the public water supply, to be exercised by such authority, subject to such recommendation as shall be given by the Board from time to time.

Examination of Sewer Outlets.

The examination of sewer outlets has been continued as in previous years, special attention having been given to the sewage-disposal works in various parts of the State. New systems of sewerage and sewage disposal were constructed during the year in Northbridge (Whitinsville), Marion and Milford, and the works in the two former towns were completed and their use begun during the year. The works at Milford were practically completed at the end of the year, but no connections with the system have yet been made.

The main sewerage works of the city of Salem, which provide also for the disposal of the sewage of the town of Peabody, were completed and put into operation on Dec. 31, 1906, and a number of sewers have already been connected with this system. A system of sewerage has been constructed in the town of Peabody also, and connections are now being made there. With the completion of these works it is now practicable to remove the sewage and especially the great quantity of manufacturing waste which formerly polluted the North River and other streams and estuaries in and about Salem and Peabody to the new outlet into the sea near Great Haste Island, about a mile from the shore of Salem harbor.

Pollution of Stony Brook.

Attention was called in the last annual report to the increasing pollution of the Stony Brook channels, and the objectionable condition of the sewerage and drainage systems in the Stony Brook valley. The Legislature subsequently passed an act (chapter 485 of the Acts of the year 1907) entitled, "An Act relative to the construction of sewerage works within the watershed of the Charles River basin by the city of Boston," which provided that the city of Boston should, in the year 1907, expend $100,000, and in each year for the next five years expend $\frac{1}{20}$ of 1 per cent. of its taxable valuation in the construction of works for the separation of sewage from surface or storm water within the watershed of Stony Brook and other areas tributary to the Charles River basin. The act further provides that no work shall be done until the plans have been approved by a board consisting of the chairman of the State Board of

Health, the chairman of the Boston board of health and the city engineer of Boston, and that the officer or board having charge of the construction of sewerage works in the city of Boston shall file with said board a plan of existing sewers and drains within the watersheds indicated, or in such portion of these watersheds as the board may designate from time to time. The only provision of this act which relates to the State Board of Health is a clause which provides that the officer or board having charge of the construction of sewerage works in the city of Boston shall, on or before the thirtieth day of November in each year, file with the State Board of Health a statement and plan for record, showing clearly the sewers, drains or other sewerage works which have been constructed within the preceding twelve months. No money appears to have been expended by the city under this act for the improvement of the conditions in the Stony Brook valley during the year 1907, though a considerable amount of sewer construction has been carried on by the city in this district under previous acts.

NEPONSET RIVER.

The passage of a new act (chapter 360 of the Acts of the year 1906) greatly strengthening legislation designed for the prevention of the nuisance resulting from the pollution of the Neponset River was referred to in the report of last year. Since the passage of that act most of the manufacturers and others in the valley discharging foul wastes into the stream have taken up the question of purifying their wastes, and many of them have presented plans of disposal systems to the Board for its advice, and in a number of cases purification works are now under construction.

In the last report it was stated that the Board had requested the Attorney-General to take action to prevent further pollution of the stream from the sewer of the town of Norwood, and that the matter was then in the hands of the court. Early in the present year the town voted to construct a system of sewerage and sewage-disposal works, and the works, plans of which were submitted for the approval of the Board in January, 1907, are now well advanced toward completion. By the completion of this sewerage system, the sewage of the town and also of several of the factories which now finds its way into the stream will be removed therefrom.

POLLUTION OF THE NORTH BRANCH OF THE NASHUA RIVER.

The health of the inhabitants in the valley of the north branch of the Nashua River below the city of Fitchburg is very seriously threatened by the offensive conditions resulting from the discharge of sewage and manufacturing waste into the stream and its tributaries, chiefly in the city of Fitchburg.

In the year 1901 the city of Fitchburg secured legislation (chapter 354 of the Acts of the year 1901) to enable it to construct a system of sewage disposal, and then caused a thorough investigation to be made and plans to be prepared for the collection and final purification of all of the sewage of the city. These plans were presented to the State Board of Health for its approval, under the provisions of the act above mentioned, on Dec. 2, 1903, and a hearing was given by the Board to all persons interested on Dec. 17, 1903.

The sewers of the city of Fitchburg are built upon the combined plan, and receive both sewage and rain water, and the plans presented for the consideration of the Board made provision both for the construction of works for the purification of the sewage and for the separation of the sewage from the storm water in all of the area of the city then served by combined sewers; but, as it was urged by the city authorities that it would be difficult for the city, on account of the expense, to do all of the work necessary immediately, it was proposed to construct the sewage-disposal works and to separate the sewage from the storm water only in a portion of the city in the beginning, and to carry out the separation in the remaining portions by a gradual process of construction that would finally result in the complete removal of unpurified sewage and manufacturing wastes from the river. In order to give the city ample time to complete the separation of the sewage from the storm water, the date determined upon for the final completion of that work was, after conference with the city authorities, Jan. 1, 1915. By this arrangement the city would have had about eleven years in which to rebuild its sewerage system to the extent necessary to prevent the further discharge of sewage into the north branch of the Nashua River; but, though four years have passed since the plans were approved, the construction of the proposed sewage-purification works has not been begun, and there is no evidence of any intention on the part of the city to carry out any portion of the plans for which the city authorities secured the approval of this Board under the circumstances above described.

Sewage and manufacturing waste from the town of Leominster are discharged into one of the tributaries of the Nashua River which enters that stream a short distance below Fitchburg. Plans for the purification of the sewage of the town of Leominster also have been prepared by the authorities of that town and approved by this Board; but the construction of a sewage-disposal system has been postponed, apparently to await action by the Fitchburg authorities, though the plans received the approval of the Board nearly four years ago.

In view of the present very offensive condition of the river and the danger to the public health in this valley from its continued pollution, the Board, as required by law, brings the matter to the attention of the Legislature for such action as it may deem necessary.

Lawrence Experiment Station.

At the Lawrence Experiment Station experiments upon the filtration of water and the purification of sewage and manufacturing wastes have been continued during the year. In water filtration special attention has been given to the operation of various combinations of filters, to test the effect of double filtration and the effect of the use of coagulants in the filtration of waters of varying degrees of pollution. In connection with these experiments tests have been made of the efficiency of high rates of filtration, — in one case as high as 100,000,000 gallons per acre daily, — a rate thirty to forty times as great as that ordinarily employed in the filtration of polluted river waters.

Investigations have been made as to the effect of continued use upon the efficiency of water filters, especially as to the effect of the accumulation of organic matter in the filtering material upon the rate of operation; and studies have been made of the relative economy of removing and washing the surface sand as compared with methods for washing it without removal.

Special attention has been given throughout the year to the work of the Lawrence city filter, and, since its completion, of the new city filter, the use of which must very soon be begun.

The experiments upon sewage purification have been continued, and experimental intermittent sand filters, contact filters and sprinkling or trickling filters have been operated as usual during the year 1907. Studies of the efficiency of septic tanks operated in various ways have been continued, and the results of the operation of the tanks and filters carefully recorded. Sand filters to which a daily dose of sewage has been applied for six days in the week have now been in use continually at the station for a period of twenty years without removal or change in the bulk of the filtering material, and also without material change in the efficiency of the purification of the sewage applied to them. Contact filters have been in continual use at the experiment station for the past nine years, and certain of the trickling filters for a period of eight years; and the accumulated results of these series of observations are most valuable in the solution of the practical problems in sewage purification and the prevention of the pollution of streams that are being constantly presented to the Board for consideration.

DRAWN AND UNDRAWN POULTRY.

The Legislature of 1906 passed the following resolve: —

CHAPTER 59.

RESOLVE TO PROVIDE FOR A COMPARATIVE INVESTIGATION OF DRAWN AND UNDRAWN POULTRY WHEN SHIPPED OR STORED.

Resolved, That the state board of health is hereby directed to investigate what unwholesome changes, if any, take place in flesh of poultry shipped or stored without the removal of the head, crop, and entrails, as compared with the flesh of poultry from which the same have been removed. For this purpose the board may expend a sum not exceeding three thousand dollars, and it shall report the result of its observations and conclusions to the next general court.

In May, 1907, the Board made a preliminary report, as follows: —

As soon as practicable after the passage of this resolve, three lots of fowl and ducks were purchased as material for the investigation. These were kept for several weeks under identical conditions as to housing, care and feed, and were then killed and prepared in the most careful manner for cold storage. The material obtained consisted of one lot of 50 ducks, which were given no food during the twenty-four hours prior to slaughter; one lot of 100 fowls similarly treated; and one lot of 50 fowls to which was given a full meal of soft feed the night before slaughter. All of each lot were killed and prepared for storage on the same day; one-half were carefully and thoroughly drawn and dressed and the rest were left undrawn. The individual birds were separately wrapped in paper and packed, and the whole of each lot were transported without delay and placed in a room of the Quincy Market Cold Storage and Warehouse Company, maintained at a temperature of about 0° Fahrenheit.

At the expiration of about two months work was begun, the chemical side of the investigation being assigned to an expert physiological chemist of long experience and thorough training, and the bacteriological side to a bacteriologist and parasitologist of the same standing. The drawn and undrawn birds were removed from storage in equal numbers as occasion required, and each bird was submitted simultaneously to both chemical and bacteriological study. The results of the work thus far obtained warrant the following conclusions: —

1. During cold storage at from 15° below to 5° above 0° Fahrenheit no chemical changes occur. This is shown by the absence in both the drawn and undrawn birds of ptomaines and decomposition products in general, and by negative reaction on the part of animals inoculated with extracts obtained from both kinds of material.

2. When removed from cold storage and exposed to ordinary temperatures, the condition of exposure being the same, the undrawn birds show better keeping qualities.

3. Freezing renders the muscular tissues more susceptible to bacterial invasion after they are thawed out.

4. The usual method of drawing poultry leads to heavy bacterial infection, which promotes more rapid decomposition than occurs in undrawn birds.

5. By ligature of the gullet below the crop, poultry can be completely drawn without any spilling of the intestinal contents, with consequent bacterial invasion of the abdominal cavity; and poultry so drawn would undoubtedly withstand decomposition and deterioration much longer than that which is undrawn.

6. The practice of depositing poultry in cold storage when in the beginning or advanced stages of decomposition, in order to save it, is dangerous to the health of the consumer, since when it is again withdrawn for sale its condition is unaltered.

7. Proper and adequate inspection of poultry as it enters cold storage is desirable, and storage of material already in process of decomposition should be prohibited.

8. The practice of placing cold-storage poultry in cold water for a number of hours for the purpose of thawing causes heavy bacterial infection, and consequently more rapid decomposition than occurs when thawing is allowed to proceed slowly at room temperature. Such treatment causes also a material increase in weight, by reason of absorption by the tissues of water, to the detriment of the purse of the purchaser, and hence is fraudulent.

Several questions in connection with the subject of cold storage of poultry are still in process of investigation, the results of which will be submitted in the final report.

The final reports of the chemist and of the bacteriologist to whom the investigation was committed are to be found in the Supplement.

LOCAL OUTBREAKS OF INFECTIVE DISEASE.

During the year seven local outbreaks of infective disease were investigated and reported in the official "Bulletin" of the Board. These included an extensive epidemic of scarlet fever in Boston, Cambridge, Somerville and Everett; another of the same disease in Gardner; one of diphtheria in Dorchester, Milton and Hyde Park; three small outbreaks of typhoid fever in Somerset, Cambridge and Somerville, and Palmer and Belchertown; and one family outbreak of trichinosis in Chesterfield. In all but the last the exciting causes of the diseases were proved to be or appeared to be spread by specifically contaminated milk. The details appear in the Supplement.

FOOD AND DRUG INSPECTION.

The number of samples of foods and drugs collected and examined during the year ended Nov. 30, 1907, was 5,684, and the total number since the work was begun in 1882 has now reached 176,674.

During the year 333 prosecutions were made in the various courts of the Commonwealth, bringing the total number to 2,843. The details are presented in the Supplement.

PROPRIETARY MEDICINES.

During the year 31 proprietary preparations containing cocaine or an excessive amount of opium were advertised as unsalable at retail, under the provisions of chapter 386 of the Acts of 1906. These included 10 proprietary brands of coca wine, the following so-called catarrh cures, namely: —

Dr. Birney's Catarrhal Powder.
Crown Catarrhal Powder.
Dr. Agnew's Catarrhal Powder.
Dr. Cole's Catarrh Cure.
I. C. R. Instant Catarrh Relief, Instant Cold Relief.
Opal Catarrh Powder.
Gem Catarrh Powder.
Standard Catarrh Powder.
Anglo-American Medicine Company's Catarrhal Powder.
The Miles Mixture for Catarrh.
Pretzinger's Catarrh Balm.

And the following: —

Allenbury's Throat Pastilles, No. 9.
Reeves' Coca and Tolu Cough Drops.
Dr. Nathan Tucker's Specific for Asthma, Hay Fever and All Catarrhal Diseases of the Respiratory Organs.
Rudolf's Kola Cardinette.
Maltine with Coca Wine.
Vin Mariani.
Vin Tonique Mariani.
Quina Laroche.
Carney Common Sense Opium Cure.

Thirty-eight convictions were secured for the unlawful sale of various of these preparations.

Inspection of Liquors.

The work of the Board in connection with the duties of the office of inspector and assayer of liquors, transferred to the Board in 1902, is reported upon in the Supplement.

Inspection of Dairies.

During the twelve months covered by this report 2,714 dairies have been inspected by the veterinarian of the Board. Of this number, 660 are situated in other States (Maine, New Hampshire, Vermont, New York, Connecticut and Rhode Island), but their product is shipped into the State for public sale; and as much of it is stale when shipped, most of it produced under such insanitary conditions that it cannot be clean, and some of it known to be from diseased animals, the attention of the Federal authorities has been called to the fact that under the national food and drug law such milk, being stale, dirty or diseased, is adulterated, and hence not entitled to enter into interstate commerce; but no action has been taken by them in the premises.

Of the total number of Massachusetts dairies visited, rather more than a third (34.27 per cent.) were free from objectionable conditions. The outside dairies yielded less favorable figures (31.06 per cent.). To the owners of the 1,805 dairies which showed insanitary conditions, letters were sent calling attention to a total of 7,243 objectionable features. The details will be found in the Supplement.

Milk as a Carrier of Infection.

Many outbreaks of infective diseases having been investigated by the Board and traced to polluted milk, it was deemed of importance to cause to be undertaken, under the supervision of the pathologist of the Board, a study of the influence of milk on the longevity and multiplication of the exciting causes of diphtheria and typhoid fever, and of other pathogenic bacteria which may gain access thereto through carelessness or accident. The results of this investigation are presented in the Supplement.

Infantile Mortality.

That infantile mortality is especially high during the hotter months of the year, and that digestive disturbances play a very important part therein, are well known facts, but systematic inquiries concerning this subject, extending over long periods, have in this country rarely, if ever, been made. During the six months beginning June 1 and ending Nov. 30, 1907, the Board investigated all of the cases of death which occurred in the city of Boston in infants under one year of age. The results of the inquiry, which show the causal relation of artificial feeding, are presented in the Supplement, with tables and charts.

Reports upon Health of Towns, Fatality of Certain Diseases, Official Returns of Deaths in Cities and Large Towns, General Health of the State, the Production, Distribution and Use of Diphtheria Antitoxin and Vaccine, and upon Bacteriological Diagnosis are presented in the Supplement.

ROUTINE WORK OF THE BOARD.

Statistical Table for the Year ended Nov. 30, 1907.

Whole number of samples of food and drugs examined,	5,684
Samples of milk examined (included in the foregoing),	2,292
Whole number of samples of food and drugs examined since beginning of work in 1883,	176,674
Whole number of samples of milk examined since beginning of work in 1883,	96,363
Number of prosecutions against offenders during the year,	323
Number of convictions during the year,	290
Amount of fines imposed,	$6,546
Number of dairies examined,	2,714
Number of packages of antitoxin of 1,500 units each issued to cities and towns,	64,807
Number of tubes of vaccine issued to cities and towns,	45,265
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,	4,646
Number of examinations made for diagnosis of tuberculosis,	1,705
Number of examinations of blood made for diagnosis of malarial infection,	31
Number of examinations of blood made for the diagnosis of typhoid fever,	705
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 75, section 52, Revised Laws,	30,527

Force employed in general work of Board at central office, State House: —	
Secretary,	1
Assistant to the secretary,	1
Clerks,	5
Messenger,	1
Sanitary inspector of dairies,	1
Total,	9

Force employed for food and drug inspection: —	
Chemists and assistants,	4
Inspectors,	3
Total,	7

Force employed at laboratory (Bussey Institution): —

Pathologist,	1
Assistants,	6
Total,	7

Under the Provisions of Sections 112 to 118 of Chapter 75, Revised Laws.

Applications for advice from cities, towns and others: —

Relating to water supply,	87
Relating to ice supply,	8
Relating to sewerage and drainage,	24
Relating to pollution of streams,	3
Miscellaneous,	3
Total,	125

Number of samples of water, ice and sewage examined chemically and microscopically at the laboratory, Room 502, State House,	5,418
Number of samples of sewage, water, ice and mill wastes examined chemically and bacterially at the Lawrence Experiment Station,	2,278
Number of samples of sand and sludge examined chemically at the Lawrence Experiment Station,	539
Number of samples of sand examined mechanically at the Lawrence Experiment Station,	161
Additional samples examined bacterially at the Lawrence Experiment Station,	4,152
Total number of samples examined,	12,548

Force employed at central office: —		
Chief engineer,	1	
Assistant engineers,	7	
Stenographers and clerks,	4	
Messenger,	1	
	—	13
At laboratory, Room 502, State House: —		
Chemist,	1	
Assistant chemists,	6	
Biologist,	1	
Stenographer,	1	
	—	9
At Lawrence Experiment Station: —		
Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	3	
	—	7
Total ordinary force,		29

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

1886,	8	1898,	75
1887,	22	1899,	79
1888,	28	1900,	104
1889,	38	1901,	105
1890,	23	1902,	93
1891,	53	1903,	129
1892,	56	1904,	125
1893,	51	1905,	105
1894,	53	1906,	130
1895,	52	1907,	125
1896,	65		
1897,	59	Total,	1,578

APPROPRIATIONS.

The appropriations for the year ended Nov. 30, 1907, as recommended by the Board in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows: —

For the general expenses of the Board,	$20,000 00
For the inspection of food and drugs,	14,500 00
For the production and distribution of antitoxin and vaccine,	15,000 00
For the purity of inland waters,	35,000 00
For the examination of sewer outlets and Neponset River,	11,000 00
For printing the annual report,	4,000 00
State inspectors of health, July 25 to Nov. 30, 1907,	15,000 00
Total,	$114,500 00

EXPENDITURES.

The expenditures under the different appropriations for the year ended Nov. 30, 1907, were as follows: —

General Expenditures.

Appropriation,	$20,000 00
Salaries,	$10,900 17
Travelling expenses,	2,485 83
Stationery,	404 31
Printing,	2,237 78
Books, subscriptions and binding,	567 89
Advertising,	26 34
Express charges,	24 80
Amount carried forward,	$16,647 12

Amount brought forward,	$16,647 12
Extra services,	346 40
Messenger,	137 02
Postage and postal orders,	701 05
Telephone and telegraph messages,	98 93
Typewriting supplies,	260 19
Special investigations,	472 66
Sundry office supplies,	866 48
Laboratory supplies,	193 10
Miscellaneous,	11 34
Total,	$19,734 29

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Year ending Nov. 30, 1907.

Appropriation,	$15,000 00
Salaries,	$5,946 67
Printing,	283 55
Stationery,	46 90
Laboratory supplies,	2,123 52
Laboratory construction,	401 66
Rent of laboratory,	1,166 66
Express,	32 48
Travelling,	6 35
Purchase of animals,	925 05
Board of horses,	2,371 29
Services of veterinary,	6 00
Food for animals,	311 67
Rental of telephone, messages and postage,	162 93
Extra services,	124 55
Ice,	111 74
Gas electric lighting and heating,	352 62
Miscellaneous,	117 92
Total,	$14,491 56

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1907.

Appropriation,	$14,500 00
Salaries of analysts,	$5,459 67
Salaries of inspectors,	4,374 97
Travelling expenses and purchase of samples,	1,773 11
Apparatus and chemicals,	1,194 65
Printing,	143 41
Services, cleaning laboratory,	100 00
Amount carried forward,	$13,045 81

Amount brought forward,	$13,045 81
Express, telephone and telegraph messages,	14 73
Sundry laboratory supplies,	168 26
Typewriting supplies,	93
Books and maps,	54 76
Extra services,	327 50
Advertising,	89 48
Total,	$13,701 47

For carrying out the Provisions of the Act to protect the Purity of Inland Waters, and to require Consultation with the State Board of Health regarding the Establishment of Systems of Water Supply, Drainage and Sewerage.

Appropriation for the year ended Nov. 30, 1907,	$35,000 00
Salaries, including wages of laborers at Lawrence Experiment Station,	$27,728 53
Apparatus and materials,	1,674 79
Rent of Lawrence Experiment Station,	150 00
Use of tools and office, Lawrence Experiment Station,	126 42
Travelling expenses,	1,861 70
Express charges,	1,032 68
Books and binding,	274 76
Maps and blue prints,	315 83
Stationery, drawing materials and typewriting supplies,	810 81
Telephone and telegraph messages, and postage,	252 02
Extra services,	375 31
Services, collecting samples and reading gauges,	16 70
Miscellaneous,	380 45
Total,	$35,000 00

For the Examination of Sewer Outlets, under the Provisions of Section 4 of Chapter 75 of the Revised Laws.

Appropriation for the year ended Nov. 30, 1907,	$11,000 00
Salaries, including wages of laborers at Lawrence Experiment Station,	$8,680 82
Apparatus and materials,	380 35
Travelling expenses,	1,462 66
Express,	116 78
Telephone and telegraph messages, and postage,	17 24
Extra services,	14 00
Services, collecting samples and reading gauges,	24 85
Books, maps and blue prints,	171 69
Stationery and drawing materials and typewriting supplies,	109 16
Miscellaneous,	22 45
Total,	$11,000 00

Expenditures under the Provisions of the Act to provide for the Establishment of Health Districts and the Appointment of Inspectors of Health.

Appropriation, June 19 to Nov. 30, 1907,	$15,000 00
Salaries,	$8,519 73
Travelling,	1,642 44
Express,	5 80
Printing,	147 25
Books and stationery,	229 38
Postage,	135 19
Typewriters and typewriting supplies,	556 00
Office supplies,	299 50
Telephone and telegraph messages,	10 18
Extra services,	32 80
Miscellaneous,	3 40
Total,	$11,581 67

HENRY P. WALCOTT.
JULIAN A. MEAD.
HIRAM F. MILLS.
ROBERT W. LOVETT.
GERARD C. TOBEY.
JAMES W. HULL.
CHARLES H. PORTER.

SUPPLEMENT.

WATER SUPPLY AND SEWERAGE.

ADVICE TO CITIES, TOWNS AND PERSONS.

ADVICE TO CITIES, TOWNS AND PERSONS.

Under the provisions of the Revised Laws (chapter 75, section 117), the State Board of Health is required to

> consult with and advise the authorities of cities and towns and persons having, or about to have, systems of water supply, drainage or sewerage as to the most appropriate source of water supply, and the best method of assuring its purity or as to the best method of disposing of their drainage or sewage with reference to the existing and future needs of other cities, towns or persons which may be affected thereby. It shall also consult with and advise persons engaged or intending to engage in any manufacturing or other business whose drainage or sewage may tend to pollute any inland water as to the best method of preventing such pollution, and it may conduct experiments to determine the best methods of the purification or disposal of drainage or sewage. No person shall be required to bear the expense of such consultation, advice or experiments. Cities, towns and persons shall submit to said board for its advice their proposed system of water supply or of the disposal of drainage or sewage, and all petitions to the general court for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of said board thereon.

During the year 1907 the Board has given its advice to the following cities, towns and persons who have applied for such advice under the provisions of this act or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply and to sources of ice supply, as follows: —

WATER SUPPLY.

Amesbury (well of F. S. Merrill).
Ashland (W. H. M. Bellows).
Auburn (spring).
Becket.
Bedford (two).
Belchertown.
Blandford.
Boston (Henry Siegel Company).
Brookfield (East Brookfield).
Chelmsford (North Chelmsford Fire District).
Chelsea (Thomas Strahan Company).
Chicopee.
Cohasset.
Easthampton.
Fall River (two).
Fitchburg.

Foxborough (State Hospital).
Framingham.
Framingham (State camp ground).
Framingham (well).
Framingham (H. R. Long Shoe Company).
Gardner (two).
Georgetown (poor farm).
Hamilton (well at Hamilton Park).
Holyoke (American Thread Company).
Hudson.
Huntington (two).
Lenox (Aspinwall Water Company).
Lynn.
Lynn (springs).
Lynnfield (F. J. D. Barnjum).
Manchester (two).
Marblehead (Children's Island Sanitarium).
Marion (two).
Marion (George F. Richards).
Marlborough (Metropolitan Water and Sewerage Board).
Maynard.
Medway.
Newbury (Dummer Academy).
Newburyport (three).
Newburyport (Chase-Shawmut Company).
Northampton (Holyoke Street Railway Company).
North Attleborough (W. G. Clark & Co.).
Northfield (Northfield schools).
Palmer (Bondsville).
Pittsfield.
Plainville.
Plymouth (spring and well).
Provincetown (two).
Revere (Metropolitan Park Commission).
Rowley (well of W. C. Foster's Sons).
Seekonk (wells).
Sharon.
Shelburne (F. C. Rowland).
Somerset (wells).
Stoneham (well of C. L. Bournival).
Stoneham (well of Healey Bros.).
Swampscott (George D. R. Durkee).
Swampscott (J. M. Bassett).
Waltham.
Waltham (American Watch Tool Company).
Waltham (Judson L. Thomson Manufacturing Company).
Ware (Pine Grove Mineral Spring).
Wareham (Wareham Fire District).
Wayland.
Westford.
West Newbury (Thomas S. Lunt).
Weston (well at Kendal Green).
Weston (well at schoolhouse).
West Springfield.
Woburn.
Wrentham.
Wrentham (State School) (three).

Ice Supply.

Chicopee (two).
Concord.
Groton (H. J. Bushway).
Whitman (F. F. Downes).
Whitman (Whitman & Abington Ice Company).
Winchester.

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Ashfield (two).
Brockton.
Canton (Neponset Woolen Mills).
Chelsea.
Dedham (Cochrane Manufacturing Company).
Dover (estate on Charles River).
Franklin.

Groton.
Hatfield (two).
Haverhill.
Hyde Park (Tileston & Hollingsworth Company).
Lexington.
Lowell.
Milford.
Newburyport.
Norwood.
Salem.
Southbridge.
Stoughton (French & Ward).
Taunton.
Walpole (Hollingsworth & Vose Company).
Winchester.
Winthrop.

MISCELLANEOUS.

Burlington (Muller Brothers).
Lynn (George E. Marsh Company).
Lynn (Illinois Leather Company).
Medford (Metropolitan Park Commission).
Somerville (Hinckley Rendering Works) (two).

PUBLIC INSTITUTIONS.

Bridgewater and Rutland (State Prison).

WATER SUPPLY.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to water supply: —

AMESBURY (WELL OF F. S. MERRILL).

OCT. 3, 1907.

To the Board of Health of the Town of Amesbury, HERBERT G. LESLIE, M.D., *Secretary*.

GENTLEMEN: — In response to your request for an examination of the water of a well located at the factory of F. S. Merrill and used by the employees for drinking, and advice as to its quality, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that while the water has been at some time considerably polluted it has subsequently been well purified in its passage through the ground, and in its present condition it is probably safe for drinking. It is important, however, that if new buildings or structures of any kind should be erected on lands about or above the well further examinations of the water be made, so that its use may be discontinued if deterioration occurs.

ASHLAND (W. H. M. BELLOWS).

SEPT. 5, 1907.

To MR. W. H. M. BELLOWS, *Homer Avenue, Ashland, Mass.*

DEAR SIR: — In response to your request for an examination of a well from which you propose to sell water for drinking in Ashland, the Board has caused the well and its surroundings to be examined and a sample of its water to be analyzed.

The results of the analysis show that the water at the present time is of good quality, but the well is located close to a neighboring brook and is apparently supplied largely at times by brook water, which can enter it directly. The brook is exposed to pollution by buildings upon its watershed above the well, and, under the circumstances, the source cannot be regarded as a safe one from which to take water for drinking.

AUBURN (SPRING).

DEC. 5, 1907.

To the Board of Health of the Town of Auburn.

GENTLEMEN: — In response to your request of Nov. 20, 1907, for an examination of the water of a spring on the State road, about a mile southwest of Auburn village, the Board has caused the spring and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

It appears that when the State road was constructed in this locality a spring was encountered, and that a basin was built about the spring and a pipe laid to convey the water to a low point at the side of the road, about 100 feet distant. This pipe at present discharges at the edge of the roadway between it and the street line, and the end of the pipe at the time the examination was made was almost completely submerged in a small pool of water formed about this outlet. It is understood that it is from this pool that water is taken for drinking by travellers on the highway. There are no dwelling houses in the immediate vicinity of this spring, but surface water from the street undoubtedly finds its way into the pool of water about the outlet pipe.

The results of an analysis of a sample of the water collected on November 21 show that at that time it was clear, colorless and odorless, contained but little organic matter and was practically free from bacteria. In its condition as found at that time the water from this outlet would probably not be injurious for drinking. The spring is, however, greatly exposed to danger of pollution, and might be badly polluted at any time and continue to be injurious for drinking for a considerable time.

In the opinion of the Board, it is desirable to remove the outlet pipe of this spring to some distance from the highway to prevent the further use of water from that source for drinking.

BECKET.

Oct. 3, 1907.

To the Committee on Water Supply, Becket, Mass.

GENTLEMEN: — The State Board of Health received from you on September 9 an application desiring its advice as to three possible sources of water supply which you are considering for the use of the village of Becket, and in response to this application has caused the proposed sources of supply to be examined by one of its engineers and samples of their waters to be analyzed.

Of the sources mentioned, Norcott Brook, so called, drains so small a watershed above the point at which it would be necessary to take the water in order to furnish a suitable pressure in the pipes that the yield of the source would probably not be sufficient for the requirements of the town.

Both Falls Brook and Yokum Pond, the other sources of supply mentioned in your application, would furnish an ample quantity of water for the requirements of the town, and the water of either source would be satisfactory for all the purposes of a public water supply, the water of Yokum Pond being considerably softer, however, than the water of Falls Brook. Falls Brook could be taken at a point much nearer the main village of Becket than Yokum Pond, and at such an elevation as to provide an adequate pressure of water in the village, but an examination of the watershed of Falls Brook shows that the area draining into its easterly branch contains a considerable number of dwelling houses with outbuildings, and that it is not desirable to take water from this brook below that branch. Above the point where Falls Brook is crossed by the road leading from Becket to Washington the watershed of the stream contains but one or two occupied dwelling houses, and the drainage area of the stream, judging from the State map, is about 1¼ square miles, though it is possible that it may be much larger than the estimate given. There is an excellent opportunity for constructing a small storage reservoir just above the road leading to Washington, and even if the watershed is no greater than is indicated by the State map, this source can, in the opinion of the Board, be developed so as to yield an ample supply of water for the requirements of Becket. It is probable that, if a reservoir should be constructed on the brook at the point indicated, and should be thoroughly cleaned and prepared for the storage of water by the removal of all soil and organic matter, the quality of the water, except in the matter of hardness, would not be very different from that of Yokum Pond.

Judging from the information thus far available to the Board, either of the sources mentioned would be an appropriate one for the supply of

Becket, and the quality of the water of the two sources would not be materially different, though the water of Yokum Pond would be somewhat softer. Surveys and a further investigation will be necessary before it will be practicable to determine which of the sources will be the most economical for the town to adopt, and the Board will give you further advice in the matter, if you so request, when the results of further investigations are available.

BEDFORD.

JAN. 3, 1907.

To Messrs. GEORGE M. DIMOND, HENRY D. LYONS and GEORGE A. SKELTON, *Bedford, Mass.*

GENTLEMEN: — The State Board of Health has considered your application for advice relative to a proposed water supply for the town of Bedford, to be taken from the ground at either of two points near the village, and has caused the localities indicated to be examined by one of its engineers.

One of the localities indicated is about a quarter of a mile north of the village, but the area from which water could be drawn is so limited that it is improbable, in the opinion of the Board, that a sufficient supply of water could be obtained in this locality.

The other location is about a mile northwest of the village, in the low land bordering the Concord River, from a quarter to a half mile east of the stream. The conditions here appear favorable, but, in the absence of tests showing the character of the ground and probable quality of the water, the Board is unable to advise you as to the practicability of obtaining a ground-water supply sufficient for the village in this locality. There are other places in the neighborhood of the village where the indications are favorable for obtaining water of good quality freely from wells, but further investigations will be necessary to determine the most appropriate source of supply.

The Board would recommend that you cause investigations to be made and test wells to be driven at the places where the conditions appear to be most favorable for obtaining an adequate supply of good water for the village; and the Board will, upon application, give you further advice in the matter when you have the results of further investigations to present.

OCT. 31, 1907.

To the Board of Water Commissioners of the Town of Bedford.

GENTLEMEN: — The State Board of Health received from you on Oct. 2, 1907, an application for advice with reference to a proposed water supply for the town of Bedford, describing the tests thus far made and requesting advice upon the following questions: —

Is your Board satisfied with the quality of the water which has been obtained at the Kenrick meadow wells?

If it is satisfied with the quality of the water and approves the locality, but desires a pumping test to determine the quantity obtainable there, what quantity would be sufficient to meet with your approval and how long a test would be required?

Should a pumping test be made, and the water from the wells we now have and propose to drive for test purposes satisfy your Board both as to quality and quantity, how much of the Kenrick property would you require us to take for protection purposes?

If a pumping test should show no deterioration in the quality of the water in this locality would it be necessary to take the entire Kenrick property?

Finally, is it possible for your Board to give an opinion as to the possibility of the location being approved under any condition?

The tests referred to have been made along the easterly bank of the Shawsheen River, between Main Street and a point a short distance north of Page Road, so called, and in the valley of a tributary of the Shawsheen River which enters it from the east a short distance south of Page Road.

The Board has caused the locality to be examined and has considered the information submitted by your engineer as to the results of the tests thus far made in the locality indicated, and has examined the results of analyses of samples of water collected and sent in by you from certain of the test wells.

In the course of the tests along the Shawsheen River, favorable indications for obtaining water freely from the ground were found a short distance above Page Road, where three of the test wells penetrated a coarse stratum from which water could be pumped quite freely with a hand pump. Little or no water was obtained from the other test wells along the river both north and south of those just mentioned.

The wells from which water was obtained most freely are located in the meadow near the river, and a considerable depth of peaty soil was encountered in sinking the wells. The water of wells in such locations has in many cases deteriorated after a longer or shorter period of use, and it is very desirable to locate the wells at a considerable distance — at least 100 feet if possible — from this meadow. It is impracticable to do so, however, in this case without placing them east of Shawsheen Road. In any case, the wells would be located very close to a considerable group of dwelling houses and other buildings which border the easterly side of the Shawsheen Road in this region, and the water would undoubtedly be unfavorably affected by drainage from this source. The cost of acquiring and removing these buildings would be large, and, considering all the circumstances, it does not seem to the Board advisable to make further tests with a view to obtaining a water supply for Bedford in this locality.

Tests made in the valley of the brook flowing from the ice pond east of the Shawsheen Road were not favorable until the neighborhood of the ice pond was reached, where water of excellent quality was obtained quite freely from one of the test wells. It is very doubtful whether enough water could be obtained there under present conditions to supply the town of Bedford after water has come into general use, but it is evidently possible to store considerable water by the construction of a higher dam in the neighborhood of the ice pond, apparently at no great expense, and thus increase materially the yield of this watershed.

If it is practicable, as seems likely, to construct a reservoir in this locality holding as much as 5,000,000 gallons, enough water might be obtained from this drainage area for the requirements of Bedford. The determination of this question will require, first, a survey to determine the practicability and probable cost of constructing a reservoir of the size indicated and the approximate outlines of this reservoir, and second, the sinking of wells in the neighborhood of the shores of the reservoir and pumping therefrom for a period of several days to determine the probable quantity of water obtainable.

The neighborhood of the ice pond appears to the Board to be the only locality in this region in which it may be practicable for Bedford to obtain a supply of good water, and should you decide to make the investigations indicated the Board will assist you by making the necessary analyses of water, and will give you further advice when the results of further examinations are available.

BELCHERTOWN.

JAN. 3, 1907.

To Mr. NELSON RANDALL, *Chairman of Board of Selectmen, Belchertown, Mass.*

DEAR SIR: — The State Board of Health has considered your application for advice with reference to a water supply for the town of Belchertown, to be taken either from the Lincoln Spring or the spring on the Buffum lot, so called, and has caused the locality to be examined by one of its engineers and samples of the waters of the sources indicated to be analyzed.

The results of these investigations show that the water of the Lincoln Spring, so called, is unfavorably affected by its nearness to the village, and that neither source is likely to furnish enough water for the supply of the town, and the Board cannot recommend the use of either of these sources.

The Board would again recommend that you cause further investigations to be made of possible sources of water supply in the neighborhood of the main village, and that in these investigations you secure the assistance of an engineer of experience in such matters.

BLANDFORD.

OCT. 3, 1907.

To the Water Supply Committee of the Village of Blandford, MR. S. G. WOOD, *Secretary.*

GENTLEMEN: — The State Board of Health has considered your application for advice as to a proposed water supply for the village of Blandford, to be taken from a spring near the headwaters of Freeland Brook, so called, and has caused the locality to be examined by one of its engineers and a sample of water collected from the stream flowing from the spring to be analyzed.

The results of the analysis show that the water is naturally of good quality for water-supply purposes. Its quality is slightly unfavorably affected at the present time by drainage from a dwelling house located above the spring, but danger of the pollution of the water from this source could be prevented by removing the sewage and sink drainage from this house in a tight pipe to some point outside the watershed of the spring.

The quantity of water flowing from the spring in the drier part of the present season, judging from measurements furnished by you, amounts to about 12,000 gallons per day. It is practicable, by locating a collecting well a short distance below the spring, to collect, in addition to the flow of the spring, a considerable quantity of ground water which drains upon some wet land bordering the brook a short distance below the spring; and, by collecting all of the water available in this locality, it is probable, in the opinion of the Board, that enough water can be obtained for the present requirements of the village.

It also appears to be possible to secure a supply of water for the village from the valley of another branch of Freeland Brook, from a quarter to a half mile north of the spring and at about the same elevation. This valley appears to be uninhabited at the present time, and it is probable that a supply of water of good quality could be obtained there.

In the opinion of the Board, by utilizing both branches of Freeland Brook an ample supply of good water can be obtained for the village of Blandford, and the Board will give you further advice in the matter, if you so request, when you have made definite plans of your proposed works.

BOSTON (HENRY SIEGEL COMPANY).

APRIL 4, 1907.

To the Henry Siegel Company, Boston, Mass.

GENTLEMEN: — In response to your request for an examination of the water of a tubular well located beneath your building, near the junction of Harrison Avenue and Essex Street, said to have been driven to a depth of 520 feet, the Board has caused the well to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water at this time was very turbid and contained a large quantity of organic matter, and was not suitable for drinking. If water should be drawn freely from the well it is possible that its quality would improve after a longer or shorter period of use; but, owing to the nearness of possible sources of pollution, it is not probable that water which may safely be used for drinking can be obtained in this locality.

If you conclude to test the quality of this water further by pumping from the well for a considerable period, the Board will make additional analyses of the water if you so request.

BROOKFIELD (EAST BROOKFIELD).

AUG. 23, 1907.

To Messrs. WARREN E. TARBELL, WILLIAM G. KEITH, WARREN R. UPHAM, WALTER B. MELLEN and EDWIN D. GOODELL, *Water Supply Committee of the Village of East Brookfield.*

GENTLEMEN: — The State Board of Health received from you on July 25, 1907, an application for advice as to a proposed water supply for the village of East Brookfield, to be taken from the ground on the westerly shore of Furnace Pond or Lake Lashaway, half a mile or more from its outlet, and has caused the locality to be examined by its engineer and samples of water from two test wells in this locality to be analyzed.

The results of the analyses show that the ground water at the location of these wells is of excellent quality for the purposes of a public water supply.

The wells penetrated a stratum of coarse material from which water could be pumped quite freely, and the indications furnished by these tests are favorable for obtaining a sufficient supply of good water for the village from the ground in this locality.

When the location of the wells or other works for collecting the water has been definitely selected, the Board will give you further advice in the matter if you so request.

CHELMSFORD (NORTH CHELMSFORD FIRE DISTRICT).

JUNE 6, 1907.

To the Board of Water Commissioners of the North Chelmsford Fire District.

GENTLEMEN: — The State Board of Health has considered your further application for its approval of the use of water from wells located at the foot of Washington Street, in Chelmsford, near the northwesterly shore of Newfield Pond, or Crystal Lake, so called, and has examined the plans presented therewith.

It appears that you have made further tests of the ground in certain localities in the neighborhood of the northerly shores of Crystal Lake, but that these tests have failed to show any other locality in that region from which water can be obtained in sufficient quantity for the supply of North Chelmsford, and you deem it less expensive and more desirable for the district to take water from the ground near the lake at the foot of Washington Street, and protect the purity of the water by taking the lands now occupied or likely to be occupied by buildings in the immediate neighborhood of the wells, and providing sewers for the removal of sewage from buildings in more remote areas, rather than to take water from some source at a much greater distance from the village.

The results of examinations of water from the test wells indicate that water pumped from them will be of good quality for the purposes of a public water supply, and the indications are favorable for obtaining a sufficient quantity of water in this locality for the requirements of the village.

The area of land which you now propose to take extends a considerable distance further back from the wells than the area proposed in the plan presented last fall, and includes two additional dwelling houses, and if this land should be taken there would remain but one dwelling house — that on lot No. 12 — within 500 feet of the wells not under control of the fire district.

By acquiring the areas of land indicated on the plan submitted, danger of the serious pollution of the proposed sources of supply can be prevented, for the present at least, and if sewerage shall be provided for any additional houses that may in future be constructed in areas in the immediate neighborhood of the lands which you now propose to acquire, further necessary protection of the supply will be provided.

The Board hereby approves the use of water taken from the ground in the neighborhood of Crystal Lake at the foot of Washington Street, and the plans presented for the protection of the purity thereof, including the taking of certain lands and the construction of sewers when necessary in areas lying about the lands and between them and the village.

The lands to be taken are shown on a plan filed by you bearing the following title: "North Chelmsford Water Supply. Plan Showing Land taken and Location of Driven Wells. Scale 50 feet to an inch. Lowell, Mass., February, 1907. Smith and Brooks, Civil Engineers."

CHELSEA (THOMAS STRAHAN COMPANY).

DEC. 5, 1907.

To the Thomas Strahan Company, Chelsea, Mass.

GENTLEMEN: — In response to your request of Nov. 25, 1907, for an examination of the water of a well located at your factory in Chelsea, and advice as to its use for drinking, the State Board of Health has caused the well and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that this water, though giving evidence of previous pollution, was, at the time the examination was made, low in organic matter and probably safe for drinking.

The well is located close to a thickly populated district containing many possible sources of pollution, and there is danger that the water may deteriorate in quality at any time and the source become unsafe for use. Under the circumstances, the Board is unable to recommend the use of the water of this well for drinking.

CHICOPEE.

JAN. 24, 1907.

To the Water Commissioners of the City of Chicopee.

GENTLEMEN: — The State Board of Health received from you on January 12 an application relative to the cutting of ice on Abbe Reservoir, one of the sources of water supply of the city of Chicopee, and has caused the locality to be examined by one of its engineers.

It appears that the Abbe Reservoir is quite small, having an area of less than four acres, and that it is being used as a source of water supply for a portion of the city.

In the opinion of the Board, the cutting of ice from such a reservoir, even under careful inspection, would involve danger of the serious pollution of the water, and the Board cannot, under the circumstances, approve the taking of ice from this reservoir.

COHASSET.

AUG. 1, 1907.

To the Cohasset Water Company, Cohasset, Mass.

GENTLEMEN: — The State Board of Health received from you on July 5, 1907, an application for advice with reference to a proposed additional water supply for Cohasset, accompanied by a report of your engineer giving an outline of the proposed works.

The plan provides for sinking a well or filter-gallery on the westerly side of the Bound Brook valley, a short distance north of Doane Street, and for supplementing the yield of the well or filter-gallery when necessary, especially in the summer season, by pumping water from the brook upon the ground about the proposed collecting works. In carrying out the latter portion of the plan it is proposed to prepare a sufficient area of filter beds so that the brook water can be applied intermittently at a rate not greater than 500,000 gallons per acre per day, and the beds are to be located as much as 100 feet distant from the well.

The Board has caused the locality to be examined by its engineer and has considered the plan presented.

There is no population in the neighborhood of the proposed filter-gallery, and the conditions are favorable for obtaining water of good quality from the ground there, but it has not been practicable thus far to obtain samples of the water from wells in that locality.

Regarding the quantity of water obtainable naturally from a well or filter-gallery at this place, it is impracticable to make a definite estimate with the information now available. It is probable that a considerable quantity of water can be obtained by means of suitable works, possibly enough to supply the town in the season of the year when the use of water is least; and there is no reason to doubt that the yield can be increased by pumping water upon the ground in the vicinity of the proposed collecting works.

Tests throughout the Bound Brook valley fail to show any more favorable locality in which to obtain water, nor does it appear to be practicable to obtain an adequate supply of good water from any other source within the limits of the town aside from the systems of wells now in use.

Considering the circumstances, the place selected appears to be the most favorable one in which to locate works for enlarging the water supply. The Board would recommend that before beginning the final construction of works you sink one or two wells at this location, and pump from them for a period of several days, in order to determine definitely whether enough water is likely to be obtained here for the requirements of the town. If enough water can be obtained in this locality to supply the town during the winter season it will probably be best to use this source for that purpose, and maintain the others only as auxiliary supplies in the summer season.

The plan of supplementing the yield of the proposed filter-gallery or wells by pumping water from the brook upon the ground about them will furnish a means of increasing their yield very materially if necessary. It is possible that better results will be obtained by the use of the ground water from beneath the swamp about 500 feet below the wells, where, it is understood, tests have already shown that ground water can be obtained in large quantity. While this water is affected by an excessive quantity of iron, such waters can sometimes be purified more readily than the highly colored swamp waters such as that flowing in Bound Brook.

If you decide to put in wells and make a further test before beginning the construction of works, the Board will analyze samples of the water and give you further advice in the matter if you so request.

EASTHAMPTON.

AUG. 1, 1907.

To the Board of Water Commissioners of the Town of Easthampton, MR. ALFRED G. KAEPPEL, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on July 13, 1907, a communication requesting the approval by the Board of the use, as a temporary supply in case of emergency, of water drawn from the Manhan River in the neighborhood of your pumping station, and in response to this request the Board has caused the proposed source of supply to be examined by one of its engineers.

The results of the examination show that this stream is directly polluted by fæcal matter at several points above the proposed intake, and, in the opinion of the Board, if water from this stream should be introduced into the water-supply system of Easthampton it would be likely to cause very serious injury to the health of the town, and the Board does not approve the taking of any water from this source for water-supply purposes.

The Board would urge that steps be taken by the town at once to secure an adequate supply of water which is safe for drinking.

FALL RIVER.

Under the provisions of section 113 of chapter 75 of the Revised Laws, revised rules and regulations were made by the Board on Aug. 1, 1907, for preventing the pollution and securing the sanitary protection of the waters of North Watuppa Pond and its tributaries, used by the city of Fall River as a source of water supply.

DEC. 5, 1907.

To the Committee on Rules and Regulations for the Government of North Watuppa Pond, Fall River, MR. JAMES SINCLAIR, *Chairman.*

GENTLEMEN: — The State Board of Health received on Oct. 3, 1907, from Mr. Spencer Borden, a copy of a proposed order of the board of aldermen providing for certain rules and regulations for the sanitary protection of North Watuppa Pond, the source of water supply of the city of Fall River. The communication is as follows: —

City of Fall River,
In Board of Aldermen, Oct. 7, 1907.

Ordered, That the rules and regulations communicated to the Watuppa Water Board by the State Board of Health, under date of Aug. 1, 1907, are hereby adopted by the city of Fall River.

In addition thereto the following rules and regulations are also made, under authority granted to the city of Fall River by chapter 114, Acts of 1891, and other acts amending and enlarging said authority, and confirmed by a decision of the Supreme Court of Massachusetts in the case of Stone *v.* Heath, 179 Mass. 368: —

Rule 17. — The deposit of night soil, the accumulation of cesspools, is prohibited at any time within the area bounded by the North Watuppa Pond on the east, Pleasant Street on the south, Highland Avenue, Winter Street, Orange Street, Eighth Street on the west, and Wilson Road on the north.

Rule 18. — In granting permits for ice cutting on North Watuppa Pond, the Watuppa Water Board shall appoint an inspector for each group of 25 men and 2 horses, or less number of men and horses if fewer are used by one ice-gatherer, employed in harvesting the ice. Said inspectors shall be paid by the companies, persons, firms or corporations for whom the ice is gathered. The inspectors shall be present at all times when work upon the ice is in progress. No person shall spit upon the ice, nor defile it in any other manner, and any person offending in this particular shall be immediately ordered to leave the ice surface, be reported to the board of health of the city of Fall River, and prosecuted for pollution of the city water supply. Each horse employed on the ice shall be inspected by the inspector of animals of the city of Fall River, and no horse suffering from glanders or other contagious disease shall be permitted to work upon the ice of North Watuppa Pond. It shall also be the duty of the inspectors named under this rule to see that droppings from horses, or any other causes for defilement of the ice, are promptly removed.

Rule 19. — The Watuppa Water Board shall grant written permits for boats to go upon the North Watuppa Pond, subject to the following regulations: —

A. No boat propelled otherwise than by sails or oars, nor any boat carrying more than three persons, shall be permitted on the pond.

B. No boat shall be upon the pond later than one hour after sunset, or earlier than one hour before sunrise.

C. All boats for which permits shall be granted must be inspected by some person appointed by the Watuppa Water Board, and found to be clean. Each boat for which a permit is granted shall have a license number given it, and said number must be painted on the outside of both sides of the bow and on the outside of the stern of said boat in plain figures not less than three inches high, of black paint on a surface of white paint, so as to be plainly seen at a distance. Every boat, before a license is granted for said boat, shall be equipped with a spittoon or other receptacle in which shall be deposited anything which might defile the water of the pond, and the contents of such receptacle must be emptied not less than one hundred feet above high-water mark when the persons occupying the boat return to the shore. The inspector or inspectors appointed by the Watuppa Water Board shall have the right to re-examine licensed boats at frequent intervals, and any boat not found in the cleanly condition which made its original license justifiable shall forthwith have its license revoked.

D. No person or persons going upon the water of North Watuppa Pond shall land on the shore of the pond, excepting at their point of embarkation, unless by reason of accident making such landing necessary, or for a period of more than five minutes.

E. An area bounded by a line running through the two groups of rocky island lying east of the water works on the east, a line from the northern island to a rock painted white on the shore of the pond on the north, a line from the southern island to a rock painted white on the shore of the pond on the south, and the mainland shore near the water works on the west, shall be a forbidden area for all boats of any kind excepting such as are for the use of officers or employees of the Watuppa Water Board in the performance of their duties. On this area of water of approximately one-half mile square, nearest the water works, no licensed boat shall encroach except as driven thereon by stress of weather. Any boat breaking this rule shall have its license immediately revoked, not to be renewed within the year when a breach of the rule caused its revocation.

F. Fishing from the shores of the pond and from licensed boats shall be permitted anywhere outside the prohibited area, excepting in the case of persons found polluting the water supply in any manner whatsoever. Such persons shall immediately be prosecuted in the manner provided by law.

G. Any boat with a license, rented by its owner, must have its owner or his duly authorized agent aboard whenever it goes upon the pond, to see that the requirements for prevention of pollution of the water supply are observed; and the licensee shall be responsible for all acts of his agent.

H. Every person before receiving a license must read these rules and regulations carefully in the presence of the officer issuing the license, and shall agree in writing, in a book to be kept for the purpose, to be governed in all things in the use of the pond by these rules, also by any other rules and regulations made by the local board of health, the State Board of Health or any other duly authorized officer or officers, which may be hereafter made to insure more certainly the absolute purity of the water supply from North Watuppa Pond.

K. Licenses for boating on North Watuppa Pond may be suspended or revoked at any time by the Watuppa Water Board, with the approval of the board of aldermen.

The Board has examined the information available as to the present condition of the water supply of the city of Fall River and has carefully considered the communication presented.

The proposed Rule 17 attempts to define an area on the westerly side of the pond within which the deposit of night soil is prohibited. The boundaries of the area within which it is proposed to apply this rule are not definitely stated, and, so far as they can be outlined upon the maps of this region, the proposed rule would apply to less than half the watershed of North Watuppa Pond, yet would be applicable in an area of 1,372 acres outside the limits of that watershed. Within the watershed of North Watuppa Pond the deposit of night soil or cesspool matter in such a manner that it might pollute or tend to pollute the waters of the pond or any of its tributaries is already prohibited by the rules adopted by the State Board of Health on Aug. 1, 1907. The question of prohibiting the deposit of night soil in extensive areas outside of the watershed of North Watuppa Pond, as proposed in the rule submitted, concerns in no way the protection of the water supply from that source.

The Board is unable to find that the adoption of such a rule would be of any assistance in securing the sanitary protection of North Watuppa Pond.

Under Rule 18 certain regulations would be provided with a view to the more complete protection of the water supply from pollution by those engaged in the cutting of ice on North Watuppa Pond. It seems to the Board desirable that horses employed on the ice should be inspected by the inspector of animals of the city of Fall River, as proposed, and that no horse suffering from glanders or other contagious disease should be permitted to work upon the ice. It is also important that droppings from horses should be removed from the ice, and that spitting upon it should be prevented, and a sufficient number of inspectors should be provided for these purposes, and to provide that these subjects may not be overlooked instructions have been given to the Watuppa Water Board to see that these precautions are observed.

If the policy hitherto pursued by the city in the protection of its water supply shall be followed in the future, the cutting of ice on North Watuppa Pond will be discontinued. Until that time it is important to protect the purity of the water, while ice cutting is being carried on, by careful inspection.

Rule 19 would, if adopted, require the Watuppa Water Board to grant permits for boats to go upon North Watuppa Pond, subject to certain regulations, but without limit as to number, and under one of the regulations (marked *F*) of this proposed rule fishing from the shores of the pond is to be permitted outside of a certain limited area apparently by any person not found polluting the water, without any restriction as to number.

The use of North Watuppa Pond for boating, fishing or purposes that attract considerable numbers of persons to its neighborhood involves, in the opinion of the Board, serious danger to the purity of the water, and the adoption of a rule and regulations such as those proposed would go far to render ineffective the excellent work thus far done by the city in protecting the purity of its water supply by securing control of the shores of the pond and the lands within its watershed. In the opinion of the Board, the proposed rule and regulations relative to boating and fishing on North Watuppa Pond submitted for its approval are unnecessary and undesirable, and the Board declines to adopt them.

The measures necessary for the protection of the purity of the water of North Watuppa Pond do not deprive the inhabitants of the city of Fall River or its neighborhood of such advantages as may be derivable from the use of a large lake as a resort for boating, fishing or other recreation, since South Watuppa Pond, which also borders the thickly settled portion of the city, is available for such purposes, and free from any of the restrictions necessary in the case of public water supplies.

The Board deems it important to add that, in its opinion, very important work remains to be done in order to protect properly the purity of the city's water supply. Large areas of land have already been acquired within the watershed of North Watuppa Pond, and considerable areas of the remaining lands within the watershed contain at present few inhabitants, and can doubtless be acquired, or their control secured, at reasonable terms if not too long delayed. There are, however, thickly populated areas in the watersheds of Cress and Highland brooks, and in the watershed of the pond south of the New Boston Road, in which the cost of land and buildings would probably be so great as to make it impracticable for the city to secure control of them, and some other plan will have to be adopted for preventing the pollution of the pond from the population on these areas. This work is urgent, but the best plan to adopt can only be determined after thorough engineering studies of the various methods by which the polluted water can be diverted or purified; and if the diversion of any water from polluted areas should be found necessary, the question of replacing the water diverted with water from watersheds not now tributary to North Watuppa Pond will require consideration.

Delay in carrying to completion the measures necessary for the protection of the purity of the city's water supply may injure the health of the inhabitants, and will very likely increase the cost of the work.

Dec. 5, 1907.

To the Watuppa Water Board, Fall River, Mass.

Gentlemen: — The State Board of Health recommends that horses employed in cutting ice on North Watuppa Pond be inspected by the inspector of animals of Fall River, and that no horse suffering from glanders or other contagious disease shall be permitted to work upon the ice. It is also important that droppings from horses should be removed from the ice, and that spitting upon it should be prevented, and a sufficient number of inspectors should be provided for these purposes.

FITCHBURG.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on May 2, 1907, for preventing the pollution and securing the sanitary protection of the waters of Wachusett Lake and its tributaries, used by the city of Fitchburg as a source of water supply.

FOXBOROUGH (STATE HOSPITAL).

MARCH 18, 1907.

To the Board of Trustees of the Foxborough State Hospital, Foxborough, Mass.

GENTLEMEN: — In response to your request for an examination of the water of a deep tubular well recently sunk in land south of the hospital, 500 feet or more southwest of the superintendent's house, the Board has caused the well and its surroundings to be examined, and samples of the water collected and sent in by the hospital authorities to be analyzed.

The evidence as to the yield of this well does not show that a sufficient quantity of water could be obtained in this locality for the requirements of the hospital.

One of the samples was collected on February and two others on March 4, after pumping steadily from the wells with a hand pump for several days. The results of the analyses show that the water is affected by pollution from some source, and that the effect of the pollution increased decidedly after pumping. The well is sunk chiefly in a seamy rock, and it is impracticable to determine the source of this pollution.

The Board is unable to recommend the use of the water drawn from this well for drinking or other domestic purposes. Water from the driven wells of the town of Foxborough is of very much better quality.

FRAMINGHAM (STATE CAMP GROUND).

APRIL 4, 1907.

To Dr. WILLIAM H. DEVINE, *Surgeon-General of Massachusetts.*

DEAR SIR: — In response to your communication of March 4, 1907, requesting information as to the condition of the water supply of the town of Framingham, the Board has caused the source of supply and its surroundings to be examined by one of its engineers, and finds that the objectionable conditions referred to last year have not been changed.

April 4, 1907.

To the Committee on Water Supply of the Town of Framingham, Mr. H. S. Dennison, *Chairman.*

Gentlemen: — A further examination of the surroundings of the filter-gallery from which the water supply of the town of Framingham is now taken and the adjacent shores of Farm Pond shows that the sources of pollution to which your attention was called last year have not been removed, and that Farm Pond is exposed to very serious danger of pollution from the deposits of excrement on its shores adjacent to South Framingham and near the filter-gallery.

The Board is informed that difficulty has been experienced in past years in obtaining an adequate supply of water from the filter-gallery for all the requirements of the town without drawing water directly from Farm Pond. Under present conditions Farm Pond is, in the opinion of the Board, an unsafe source of public water supply, and the Board would recommend that you take such measures as may be necessary to provide an adequate supply of good water to meet all the requirements of the town during the coming summer.

When you have prepared plans for enlarging or improving the supply the Board will advise you concerning them if you so request.

Framingham (H. R. Long Shoe Company).

July 9, 1907.

To Mr. H. L. Egan, *President, Middlesex Building Company, South Framingham, Mass.*

Dear Sir: — In response to your request of June 7, 1907, for an examination of the water of a well located near the factory of the H. R. Long Shoe Company in South Framingham, and advice as to its quality, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

It appears from information furnished by you that the well is 125 feet deep, the lower portion of it being in rock, and that the supply obtainable is about 35 gallons per minute. The Board is also informed that it is proposed to discharge the sewage from the factory into the Framingham sewers.

The results of an analysis of a sample of water from the well collected recently show that the water at that time was turbid and colored, and contained a larger quantity of iron than is present in good ground waters, but the quantity of organic matter present was small, and the indications are that the turbidity and color would disappear if water should be drawn regularly in considerable quantity from the well.

So far as can be judged from the information now available, water can be obtained from this source which would be safe for drinking, but the Board would recommend that a further test be made after a larger quantity of water has been pumped from the well.

Framingham (Well).

Oct. 3, 1907.

To the Board of Health of the Town of Framingham, Mr. Charles N. Hargrave, *Chairman.*

Gentlemen: — In response to your request for an examination of the water of a well at No. 7 Eames Street, and advice as to its quality, the Board has caused the well and its surroundings to be examined and samples of the water to be analyzed.

The results of the analyses show that the water of this well is turbid and slightly colored, and that it has at some time been considerably polluted, and the Board does not regard it as safe for drinking.

Gardner.

June 11, 1907.

To Messrs. Charles W. Conant, Arthur P. Derby, Alec E. Knowlton, George E. Greene and George A. Dunn, *Committee on the Prevention of the Pollution of Crystal Lake by the Crystal Lake Cemetery.*

Gentlemen: — The State Board of Health received from you on May 10, 1907, a communication stating that at a meeting of the citizens of Gardner you had been appointed a committee to investigate certain questions relating to the prevention of the pollution of Crystal Lake by the cemetery on its shores, and requesting the advice of the Board in the matter. The questions submitted were as follows: —

> Whether the public health is endangered by drainage from the cemetery into Crystal Lake.
>
> The advisability of the construction of an intercepting drain along the lake front, whereby any drainage from lots in the cemetery towards the lake shall be intercepted and carried off the lake watershed.
>
> We are also directed to consider the question of a location for a new cemetery.

It appears that one of the plans suggested for counteracting the possible effect of the cemetery upon the lake was to construct an intercepting drain in the cemetery along the westerly side of Crystal Lake Avenue, at a distance of 30 or 40 feet from the edge of the lake, consisting of pipe laid with open joints surrounded with porous material to within a foot of the surface, to convey the drainage to some point outside the watershed. In connection with this drain it is proposed to put in a concrete wall between the drain and the lake to prevent loss of water from the lake.

The Board has caused the lake and its surroundings to be examined by its engineer and samples of the water of various drains entering the lake to be analyzed.

The watershed of Crystal Lake contains at the present time a little over 100 dwelling houses, practically half of which are within the watershed of the portion of the lake lying southwest of the railroad and the others in the watershed of the main part of the lake, most of them on lands which drain directly into its southerly end in the immediate neighborhood of the pumping station. All but 9 or 10 of the dwelling houses and buildings within the watershed of the lake, from which sewage may be discharged, are connected with the public sewers, and the sewage is carried out of the watershed. The remaining dwelling houses and buildings are not within reach of the sewers at the present time. There is also one large boathouse on the lake located very close to the pumping station, and the lake is evidently used to a considerable extent for boating and fishing.

From the records of the water department it appears that no water has run to waste from the lake for several years, and that its surface is now about 6 feet below high water. A comparison of the consumption of water by the town with the capacity of the lake in a series of dry years indicates that the quantity of water now being drawn from the lake is considerably in excess of its capacity, and that an additional supply is necessary.

The results of analyses of water from the lake and from various small tributaries show that considerable polluting matter enters the lake, not only from the cemetery but through the main tributary discharging into the northeasterly part of the lake, and from various small drains or streams near its southerly end, especially in the immediate neighborhood of the pumping station.

It is doubtful whether a drain can be constructed through the cemetery near the shore of the lake as now proposed which will intercept and remove all of the polluting drainage percolating toward the lake, and the removal of drainage from the cemetery, if it were practicable, would not, in the opinion of the Board, remove the more objectionable portion of the polluting drainage which now finds its way into the lake.

It has been suggested that the small portion of the lake southwest of the railroad might be filled with gravel, and that surface drainage from all the densely populated areas might at the same time be diverted from the lake; but the expense of such a plan would be large, and the diversion of water from the lake would further hasten its depletion.

In the opinion of the Board, it is important, before diverting any water from the lake, to secure an additional water supply sufficient for the requirements of the town. Whether it will then be best to divert drainage from the lake or to take other measures for preventing its pollution will depend very largely upon the source or sources selected, and the method of connecting them with the present sources or of using them independently. These questions can, in the opinion of the Board, best be considered together, and, under the circumstances, the Board would recommend that the town cause an investigation to be made as soon as practicable, with the assistance of an engineer of experience in matters relating to water supplies, to determine the most appropriate source of supply for the town and the best practicable plan of using it, independently or in connection with the present sources, and of preventing the pollution of the present sources or avoiding danger from such pollution. The Board will assist in these investigations by making the necessary analyses of samples of water, and will, upon request, give further advice when the results of further investigations are available.

Nov. 7, 1907.

To the Board of Water Commissioners of the Town of Gardner, Mr. George N. Dyer, *Chairman.*

Gentlemen: — The State Board of Health received from you on Aug. 21, 1907, an application requesting its advice as to the use of Perley (or Kneeland) Brook in Gardner as an auxiliary source of water supply, and subsequently, on October 2, a report of your engineer was submitted describing the proposed plans.

The plan provides for constructing a storage reservoir on Perley Brook, holding about 23,000,000 gallons, on the site of the Perley mill pond, and pumping water from this reservoir into Crystal Lake in such quantity as may be required to keep the lake up to its normal level. It is recommended that the town acquire two of the farms on the watershed of Perley Brook, from which the brook might be polluted, and it is suggested that the cleaning of the pond and brook would probably remove the color of the water. It is also recommended that you purify the water of the brook that flows into the lake through the Heywood place, and remove objectionable discharges into the lower end of the lake. An estimate of the cost of cleaning the proposed reservoir on Perley Brook is presented, in connection with an estimate of the cost of the dam and other works, but no plans are given for the cleaning or other improvement of Perley Brook, or for the improvements suggested about Crystal Lake.

The Board has caused the proposed source of auxiliary supply to be examined by its engineer and samples of the water to be analyzed, and has considered the report presented and other available information as to the present and proposed sources of water supply of the town of Gardner.

If the quantity of water obtainable from Perley Brook under the proposed plan should be pumped into Crystal Lake there is no doubt that the latter source could be filled again, and a sufficient quantity of water obtained from the two sources together to furnish an adequate supply of water for Gardner for several years in the future.

The water of Perley Brook has ordinarily a very high color and contains a large quantity of organic matter. It is possible that the quality of this water could be improved materially by improving the channel of the brook and draining the swamps on its watershed, but it is unlikely that the color could be removed by any practicable improvement of that kind, and no information has been presented which would indicate the degree of improvement that it would be practicable to effect, the extent of the works required or their probable cost. If introduced into Crystal Lake in its present condition, using the works proposed, the water of Perley Brook is likely to have a very unfavorable effect upon the appearance, taste and odor of the water of Crystal Lake.

The lake is being seriously polluted at the present time by drainage from the densely populated areas about its southerly and easterly shores, and the question of removing this pollution has already been considered by the town, but it does not appear that any thorough investigation to determine the best method of improvement has yet been made. The efficient protection of the lake from pollution, or the removal of the effects of pollution, may require extensive and costly works, and the diversion of a part of the watershed of the lake may be found necessary or desirable, in which case it would be desirable to provide for a larger additional supply than is now proposed.

Under the circumstances the Board is unable to advise you as to whether the proposed plan would be an appropriate one for enlarging the water supply of Gardner or not, and cannot recommend its adoption at the present time.

As the town has already been advised in a previous communication, the questions of enlarging and improving the water supply of Gardner and protecting the purity of the water should be considered together, and a thorough investigation will be necessary before satisfactory conclusions can be reached as to the best plan to adopt. These investigations should include a study of the feasibility of diverting objectionable drainage from the lake, the means by which this can be accomplished efficiently and the probable cost of the work. They should include also a careful consideration of all of the work to be done in the introduction of an additional supply, including the necessary improvements within the watershed of any proposed additional source. The results of these investigations may involve a consideration of the question of filtering the water or introducing a supply from some new source, and these questions should be carefully considered.

The Board would recommend that these investigations be taken up without delay and that they be carried to completion as soon as practicable. The Board will assist in these further investigations by making the necessary analyses of water, and will, upon application, give you further advice in the matter when you have the results of further investigations to present.

GEORGETOWN (POOR FARM).

Nov. 7, 1907.

To the Board of Overseers of the Poor, Georgetown, Mass.

GENTLEMEN: — In response to the request of Mr. B. D. French, superintendent of the Georgetown Poor Farm, for an examination of the water of the well now used for the supply of that institution, and of a spring from which it is proposed to obtain a supply in future, the Board has caused the well and spring to be examined and samples of their waters to be analyzed.

The water of the well has a disagreeable odor and contains a much larger quantity of organic matter and bacteria than is found in good well waters. The Board would advise that its further use be discontinued.

The results of the analysis show that the quality of the water of the spring is not wholly satisfactory in its present condition: and while this source can probably be used for the purpose proposed, the Board would advise that the spring be cleaned out and thoroughly covered and protected from the entrance of surface water, and that a suitable overflow or waste pipe be provided so that the water therefrom may be obtained without dipping it directly from the spring. When the changes suggested have been made the Board will, upon request, make a further analysis of the water, and will then advise you as to the use of this spring as a source of water supply for the Poor Farm.

HAMILTON (WELL AT HAMILTON PARK).

AUG. 1, 1907.

To MR. S. H. BATCHELDER, *16 State Street, Boston, Mass.*

DEAR SIR: — In response to your request of July 17, 1907, for an examination of the water of a well used as a source of water supply by about 25 families at Hamilton Park, Hamilton, Mass., the Board has caused the well and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water has at some time been considerably polluted, and the quantity of organic matter present is somewhat larger than is found in good ground waters. The pollution is probably caused by sewage deposited upon the ground at the numerous cottages surrounding the park in which the well is located. It is possible that the water may also be unfavorably affected by the waste water which is discharged into the ground a short distance from the well.

While the water of this well is probably safe for drinking at the present time, its surroundings are such that the effect of the pollution may become more serious at any time, and the Board would recommend that some other source be secured and the use of water from this well for drinking discontinued.

HOLYOKE (AMERICAN THREAD COMPANY).

SEPT. 13, 1907.

To the American Thread Company, Holyoke, Mass.

GENTLEMEN:—In response to your request for an examination of the water of two deep tubular wells located on the premises of the Merrick Mills in Holyoke, from which it is proposed to take water to supply to the employees of the factory for drinking, the Board has caused the wells and their surroundings to be examined and samples of their waters to be analyzed.

The results of the analysis of the water from the well at Mill No. 1 show that it has at some time been considerably polluted, though at the time these samples were collected it was quite thoroughly purified before entering the well. The water is also very hard, and on that account objectionable for use for drinking.

The water of the well at Mill No. 3 is of better quality in some respects than that of the well at Mill No. 1, but the hardness of this water is excessive.

Neither source can be regarded as a desirable one, and the Board cannot recommend the use of the water of either of these wells for drinking.

HUDSON.

JAN. 3, 1907.

To the Board of Water Commissioners of the Town of Hudson.

GENTLEMEN:—The State Board of Health received from you on Jan. 2, 1907, an application requesting its approval, under the provisions of chapter 242 of the Acts of the year 1897, of the purchase of a farm containing about 70 acres of land, with the buildings thereon, situated in Berlin, Mass., and nearly all of which is within the watershed of Gates Pond, the source of water supply of the town of Hudson, and in response to this application has caused the locality to be examined by one of its engineers.

The area which it is proposed to purchase extends along the shore of Gates Pond for a distance of a little over half a mile, and extends back from the shore for a maximum distance of 1,200 feet.

In the opinion of the Board it is important for the town to secure control of the lands along the shores of Gates Pond and in its neighborhood in order to protect the purity of the water, and, by the purchase of the land in question, the town would secure control of almost all of the buildings now situated within the watershed of the pond, including most of the summer cottages in its neighborhood.

The Board approves the purchase of the lands shown upon the plan submitted under the provisions of chapter 242 of the Acts of the year 1897.

The area of land taken and which is hereby approved is shown upon a plan filed in this office, which bears the following title: "Plan of Land Purchased by the Town of Hudson, Mass., from Frederick A. Fosgate & Joel H. Fosgate Est. at Gates Pond, Berlin, Mass. Area 70 A. 32 Rds. Scale 1 in. = 100 ft. G. Woodbury Parker, C.E." The above plan was filed in the office of this Board Dec. 31, 1906.

HUNTINGTON.

SEPT. 5, 1907.

To the Board of Water Commissioners of the Town of Huntington.

GENTLEMEN: — The State Board of Health has considered your application for the approval of the plan of taking water from Cook Brook as a permanent auxiliary water supply for the town of Huntington, to be used at times when the quantity of water furnished by your regular supply is inadequate, and in response to this application has caused the present and proposed sources to be examined by one of its engineers.

The water of Cook Brook, the proposed source of auxiliary supply, is naturally of good quality, but there are many dwelling houses with their outbuildings within this watershed, and the stream is greatly exposed to danger of pollution. In the opinion of the Board, its waters could not with safety be used for drinking, and the Board does not approve the use of that source as an auxiliary water supply for the town of Huntington.

Investigations made at the time your water supply was introduced show that it would be practicable to increase the yield of Cold Brook by constructing a reservoir on one of its tributaries and supplementing it, if necessary, with water diverted by gravity from Black Brook, and further examination leaves no reason to doubt that a very large increase in your supply can be made in that way, providing the dams be made tight and the other works built in a thorough manner so that an excessive quantity of water will not be lost by leakage; but time would be required to build these works and they could not be built in time to be of much advantage in meeting the present emergency.

So far as the examinations made by the Board show, the plan by which it is most likely that an adequate supply of good water can be obtained at a reasonable cost and within a short time will be to sink wells in the valley of the Westfield River in the neighborhood of the mouth of Cold Brook or of Cook Brook. The wells should be located at least 100 feet from the Westfield River, in some place where they are unlikely to be injured at times of high water. If it is found practicable to obtain enough good water by this plan to meet the present emergency, a temporary pumping plant could be provided and the water pumped into your present main pipe. By entering upon this work at once it is possible that a sufficient additional supply of water for the requirements of the town can be obtained within a very short time. The work should be done under the direction of an engineer of experience in such matters, and the Board will assist you by making the necessary examinations of water from any wells which it may be proposed to use.

Nov. 7, 1907.

To the Board of Water Commissioners of the Town of Huntington.

GENTLEMEN: — The State Board of Health has considered your application for advice as to the taking of an additional supply of water for Huntington from certain springs in the valley of Woodruff Brook, and has caused the locality to be examined by its engineer and samples of the water to be analyzed.

The results of the analyses show that the water of these springs is of good quality for water-supply purposes, but the quantity which they will supply in a very dry season is unlikely to add very materially to the quantity of water now available for the use of the town in such a season. It might be practicable, by constructing a reservoir on Woodruff Brook, to furnish an adequate supply for the town, in connection with the present sources, for several years in the future, but the stream receives the wash from the highway which passes through the valley, and there are several buildings within the watershed of the brook so situated that the stream is liable to be polluted by them, and these buildings should be acquired and removed if the source is to be used for the supply of the town. The diversion of the wash from the highway would probably not be practicable.

There are other sources in the neighborhood of Huntington from which it is likely that an additional supply of good water can be obtained at less expense than from the source now under consideration, and the Board would advise that you cause a thorough investigation of all the available sources to be made, with the assistance of an engineer of experience in matters relating to water supply, to determine which source is likely to be most appropriate of those available.

The Board will assist you in these investigations by making the necessary analyses of water, and will give you further advice in this matter when you have the results of further investigations to present.

LENOX (ASPINWALL WATER COMPANY).

SEPT. 13, 1907.

To the Aspinwall Water Company, Lenox, Mass., MR. CHARLES H. WRIGHT, *President.*

GENTLEMEN: — The State Board of Health received from you on July 31, 1907, plans of certain lands, reservoirs, wells, pipe lines, etc., located in the town of Lenox, Mass., accompanied by the following application, under the provisions of chapter 515 of the Acts of the Legislature of the year 1907: —

> The Aspinwall Water Company, as required by section 1 of chapter 515 of the Acts of the General Court of Massachusetts for the year 1907, herewith file with you plans of the sources, lands, reservoirs, wells and other works which it has acquired or intends to acquire in Lenox, Mass.
>
> These plans are five in number, consisting of general plan of the town of Lenox, with contour elevations, illustrating watersheds and general location of the whole plant, together with some minor details of the plant, and four other plans, A, B, C and D, plan A showing storage reservoir, wells and pump house, B showing hotel and artesian well system, C showing location of pipe line, Pine Tree Pond, storage tank and connection between storage reservoir and Aspinwall Hotel, and plan D showing details of construction of large storage well of 100,000 gallons' capacity.
>
> These plans, together with the drawings and papers thereto attached, contain upon them full information as to the construction, location and relation of this plant to the adjoining territory in Lenox.
>
> This company also respectfully requests that you will cause an examination of said sources and works to be made, and certify to the Commissioner of Corporations such of the sources, lands, reservoirs, dams and other works as you find necessary and suitable for water supply of this section, in the manner set forth in section 1 of said chapter 515.

The sources of water supply, lands and works which it is proposed by the company to acquire are shown by the plans submitted with the application, and may be summarized briefly as follows: —

A reservoir having a capacity of about 300,000 gallons, located on the Yokun River about 1,487 feet below the reservoir used by the Lenox Water Company and having a tributary watershed — exclusive of that of the Lenox Water Company's reservoir — of about .12 of a square mile as measured by the State map; a well, located in the valley of the Yokun River about 525 feet below the reservoir, said to have a diameter of 30 feet and a depth of 25 feet; a number of tubular wells within a radius of about 205 feet of the large well, but for the most part down stream therefrom; three gasoline engines and three triplex pumps inclosed in a wooden building, by means of which the water is pumped to a tank and to the Hotel Aspinwall; suction pipes connecting the reservoir and well with the pumping station, and a force main 4 inches in diameter leading from the pumping station to the tank and hotel, the aggregate length of pipe lines being approximately 8,052 feet; another small reservoir, known as Pine Tree Pond, located near the pipe line between the standpipe and the hotel, outside of the watershed of the Yokun River; and a small pumping station containing a gasoline engine and pump, by means of which water of the pond is pumped into the main pipe.

In addition to the foregoing it is proposed to acquire certain riparian rights along the Yokun River. It is also proposed to acquire 10.3 acres of land more or less in the valley of the Yokun River, including the lands in which the wells and a part of the reservoir are situated, but it does not appear to be the intention to secure rights to lands in which the pipe line is laid or upon which the standpipe is located.

A system of deep tubular wells, with pumps, tanks and connections, and a pipe through which water can be pumped to the hotel, is also shown on the plans presented, but, by your request, is not at present to be considered as part of the works which the company desires to acquire at the present time.

The Board has caused the sources of supply to be examined by its engineer and samples of their waters, so far as obtainable, to be analyzed, and has carefully considered the plans presented.

The results of analyses of the water of the well in the valley of Yokun River show that it is of good quality for the purposes of a public supply. The waters of the reservoir in this valley and of Pine Tree Pond are also naturally of good quality, but are objectionable at times in the summer season on account of organic growths. During much of the year these waters will probably be suitable for drinking. No water was obtainable from the tubular wells, which were said to have become filled with sand.

The quantity of water which the sources indicated can be depended upon to yield is very limited. The total area of watershed tributary to the reservoir is about .12 of a square mile, as measured from the State map, and an additional area of about the same size may be tributary to the large well, which is located below the reservoir. At the time that the works were visited by the engineer of the Board the reservoir in the valley of the Yokun River was nearly empty, and the tubular wells were found to have become useless.

The amount of water obtainable from Pine Tree Pond is insignificant, and it does not appear that the company is authorized to use water from that source.

The works appear to be designed for the supply of the Aspinwall Hotel, and, while they may be adequate for that purpose, their capacity is insufficient for the requirements of the whole district, or for any considerable portion of it aside from the hotel.

In order to provide an adequate supply for the district in question, new sources and works would have to be provided, and it is doubtful whether any of the works which it is now proposed by the Aspinwall Water Company to acquire will be necessary or suitable for the purpose.

The only portions of these works which, in the opinion of the Board, might be suitable for use in supplying the district are the reservoir and large well in the valley of the Yokun River. These sources might possibly be used in connection with other works for collecting surface or ground water lower down the valley of this stream; and in case it should be found to be practicable to obtain a further supply of good water for the district from this valley, it might be desirable for the company to acquire this well and reservoir for use in connection therewith; but until further investigation shall show that a sufficient supply of good water for the requirements of the district can be obtained in this valley, the Board will be unable to regard the reservoir and well as necessary and properly situated for the supply of the district.

The Board is unable to certify to the Commissioner of Corporations that any of the works which it is proposed by the Aspinwall Water Company to acquire for the supply of the district in the northerly part of Lenox, described in chapter 235 of the Acts of the year 1904, are necessary or suitable or properly situated for that purpose. When other sources have been found which will yield a reasonable amount of water for the district, the Board can determine whether the reservoir and large well are necessary and properly situated to form a part of the necessary works.

LYNN.

Under the provisions of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on May 2, 1907, for preventing the pollution and securing the sanitary protection of the waters of Breed's Pond, Birch Pond, Walden Pond and Hawkes Pond and their tributaries, used by the city of Lynn as sources of water supply.

LYNN (SPRINGS).

AUG. 1, 1907.

To the Board of Health of the City of Lynn, MR. GUSTAVUS A. BADGER, *Clerk.*

GENTLEMEN: — The State Board of Health has considered your application for advice as to the quality of the water of certain springs from which water is taken for sale to the public in the city of Lynn, the springs indicated being the Moose Hill, Electric, Sterling Street, Lovers' Leap, Graham and Pocahontas springs, so called, the Moose Hill being located in Swampscott and the Pocahontas in Lynnfield.

Concerning the Moose Hill Spring, you have already been advised definitely in previous communications, and concerning the Graham and Pocahontas springs there appears to be nothing to add to previous statements, no change having taken place in the conditions affecting these sources, the watersheds of which are free from pollution.

The analyses of the water of the Electric and Sterling Street springs show no material changes as compared with previous tests.

The water of the Lovers' Leap Spring has changed but little in quality in recent years. The spring is situated in a populated region, and, while the water is probably safe for drinking at the present time, it is advisable that it be examined from time to time and its use discontinued if the quality deteriorates.

LYNNFIELD (F. J. D. BARNJUM).

FEB. 11, 1907.

To MR. F. J. D. BARNJUM, *Lynnfield Centre, Mass.*

DEAR SIR: — In response to your request of Jan. 10, 1907, for advice as to the quality of the water of a well located near Pillings Pond, in Lynnfield, from which water is taken for the supply of a number of families, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water contains a larger quantity of organic matter than is found in good ground waters, and the quantity of iron present is so large as to make the water objectionable for some domestic uses. There is no evidence that the well is being polluted or that its waters are unsafe for drinking.

MANCHESTER.

JAN. 23, 1907.

To the Board of Water Commissioners of the Town of Manchester.

GENTLEMEN: — The State Board of Health has considered your application for advice as to an additional water supply for Manchester, to be taken from wells in the Beaver Dam Meadow, so called, near the Essex

Road, and has examined the results of further tests in this valley by means of wells and the observations made during the recent pumping test. The Board has also examined the results of numerous analyses of the water of the various test wells, and the results of experiments upon the filtration of the water made during a period of about one month, ending Dec. 23, 1906.

It appears from the information presented that the wells with which the test was made were located on the easterly side of the Essex Road, and were driven through peaty soil or muck and fine sand and clay into a stratum of gravel which was reached at a depth of from 40 to 45 feet, and which was not passed through.

During the pumping test — which was begun in the latter part of September and continued, with some intermissions, until the 15th of November — 20 wells were connected with the pumps and water was pumped at various rates. At the beginning a rate of 500,000 gallons was maintained from September 28 until October 5, but the level of the water in the observation wells, located at a considerable distance from the group connected with the pumps, fell away rapidly, indicating that the quantity being drawn was in excess of the capacity of the source at this time, and the rate of pumping was reduced to 300,000 gallons per day. Upon the change to this rate the water rose quickly in the observation wells for the next two days, but subsequently rose much more slowly, until a heavy rain storm occurred, in which there was a precipitation of more than 2 inches, when a further rise in the water of the wells took place, and the rate of pumping was increased to 400,000 gallons per day. At this rate — which was maintained from October 11 to October 22 — the level of the water of the wells went down steadily and quite rapidly. From October 22 to November 8 water was pumped during eight hours of the day at the rate of 400,000 gallons, the quantity drawn each day being about 133,000 gallons. Under these conditions the water rose gradually, but on November 8 the rate of pumping was changed to 700,000 gallons per day for eight hours, or a total of 233,000 gallons per day, when the level of the water in the observation wells began to go down, but rose again after a heavy rain on the 12th.

Considering the fact that the season was not an exceptionally dry one, that no water had been drawn from the ground in this region previous to these tests, and that heavy rains fell during their progress, it is improbable that a yield as great as 300,000 gallons per day can be obtained continuously from these wells in a very dry season, and in the latter part of such a season the yield might fall to a quantity very much below that amount.

The gravel stratum from which water was obtained is of limited extent in the region of the present wells, but the test wells subsequently driven in the swamp west of Essex Road show that it extends for a considerable distance up the valley of the brook. A few observations were made upon the height of the water of several test wells above the Essex Road, all of which showed that the water was being affected by the pumping.

The results of the tests, as a whole, indicate, in the opinion of the Board, that, while the quantity of water obtainable from the ground in the valley of Beaver Dam Brook is not great, a very considerable additional supply of ground water can be obtained for the portion of the year when an additional supply is necessary by the construction of suitable collecting works in the region near Essex Road in that valley.

The quality of the water of the test wells is shown by analyses of samples collected at frequent intervals during the pumping test. The water was slightly turbid and milky, especially toward the end of the test, and some of the samples contained a slight sediment, though most of them were clear. The water was odorless and contained but little organic matter, and the quantity of iron, though large enough to cause the formation of a considerable precipitate on exposure to air, was not as great as had been indicated by previous tests.

The quantity of iron in the water of the present sources is insignificant, and, as it is not likely to be necessary to draw a large proportion of the water supply of the town from the proposed new source, for the present at least, there is a question as to whether the supply to the town would be objectionable if for a time in the beginning some of the water of the proposed source should be mingled with that of the present sources without filtration. Nevertheless, precipitation might occur, and, judging from experience with other similar waters, the quantity of iron in the water of the proposed new source is likely to increase materially with continued use.

The experiments upon the filtration of this water have been insufficient to show whether the methods used could be depended upon to purify the water sufficiently. They show, however, that, with the small quantity of iron that is likely to be present in the water in the beginning, it can be filtered satisfactorily for a period of a month or more. It is unlikely that for several years the use of water from the proposed new source would be necessary for more than a limited time during the drier portion of the year, and it is probable that by aërating the water, and passing it through a sand filter, sufficient purification can be effected during the period when it is necessary to use the water to make it unobjectionable when mixed with the water of the present sources.

Since there appears to be no better source from which the town can now obtain an additional water supply, and an additional water supply is greatly needed in the drier portion of the year, it seems necessary to use the water of the sources now proposed as an auxiliary supply; but the Board would recommend that provision be made for purifying this water by filtration through sand.

DEC. 5, 1907.

To the Committee on Additional Water Supply of the Town of Manchester,
MR. RAYMOND C. ALLEN, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Nov. 23, 1907, an application for advice with reference to a proposed additional water supply for the town of Manchester, to be taken from Gravel Pond, in the town of Hamilton, supplemented by water from Round and Coy's ponds, these sources to be used as supplementary to the wells in the valley of Sawmill Brook, from which the present supply of the town is drawn. The application is accompanied by plans showing the results of careful surveys of the watershed and capacity of Gravel Pond, and the location of that pond with reference to others in the region, and by a report of your engineer, Mr. Desmond FitzGerald, giving the results of the investigations of the various sources of water supply available for Manchester, and recommending the use of Gravel Pond as a source of additional supply, supplemented by the use of water from Round Pond when necessary.

The Board has caused the proposed sources of supply to be examined by its engineer and samples of their waters to be analyzed, and has carefully considered the report and plans presented.

The capacity of the present sources of supply is sufficient for the town during six and possibly eight months of the year, but during the drier portion of the year, from June to September inclusive, the yield of these sources is insufficient for the requirements of the town, and an additional supply is required for use chiefly during these months.

The water of Gravel Pond, the proposed source of additional supply, has very little color and is of good quality for the purposes of a public water supply. Its watershed contains no permanent dwelling houses, and the land about the pond is so controlled that it is unlikely that any considerable settlement will take place there in the future.

The pond is very deep and holds a very large quantity of water in proportion to the size of its watershed, which has an area of only about 80 acres, exclusive of the area of the pond. The natural yield of the pond is estimated by your engineer to be about 135,000 gallons per day in the driest periods, and its storage capacity is so great that the whole annual yield can be made available in the months of the greatest consumption, so that a quantity of water amounting to from 350,000 to

400,000 gallons per day can always be obtained from the pond during the four summer months in the driest years. There would, moreover, if the draft were not ordinarily greater than the amount stated, always remain a large quantity of water stored in the pond which might be made use of in case of emergencies, but when the use of water becomes greater than the natural yield of the pond it will be best to introduce water from some new source before the quantity of water in the pond becomes materially reduced.

The plan submitted provides for supplementing the supply from Gravel Pond, if necessary in the future, by diverting into it water from Round Pond, situated close by, and from which water could be diverted into Gravel Pond by gravity when the surface of the latter has been drawn down. The water of Round Pond is very highly colored and contains a large quantity of organic matter, and, while small quantities might be introduced from that source into Gravel Pond without affecting seriously the quality of the water of the latter source, the introduction of larger quantities would be likely to have a noticeably unfavorable effect, and it is desirable to improve the quality of Round Pond water in some way if possible before diverting any considerable quantities of it into Gravel Pond. The lands about Gravel Pond appear to be composed largely of gravel or other porous soil, and it is probable that if Round Pond water should be pumped upon prepared areas near the shores of Gravel Pond, and allowed to percolate slowly through the ground into the latter source, its quality would be so greatly improved that it would not affect unfavorably the water of Gravel Pond.

Unless the use of water in Manchester shall increase more rapidly than seems likely at the present time, the use of Round Pond water will not become necessary for several years at least, and there will be ample time to provide a satisfactory means of purifying the water before its use becomes necessary.

In the opinion of the Board, the plan presented for obtaining a supplementary water supply for the town of Manchester by taking water from Gravel Pond, supplemented when necessary with water from Round Pond, improved by treatment in some suitable manner for the removal of color and organic matter, is the best practicable method of increasing the water supply of the town.

In using water from Gravel Pond in connection with the present sources of supply it is important that the present sources be used to their full capacity in order to avoid the unnecessary depletion of the storage in Gravel Pond. For this reason it is very important that the heights of water in the wells from which the present water supply is drawn and in Gravel Pond be observed at frequent intervals, and that records of these observations be carefully kept. It is also important that careful records be kept of the quantity of water drawn from each source in each year. Whenever it becomes evident from these records and observations that the quantity of water being used from the present sources of supply and from Gravel Pond is in excess of the probable capacity of all of these sources in a series of dry years, it will be desirable to begin the introduction of water from Round Pond in order to avoid the serious depletion of the storage in Gravel Pond.

MARBLEHEAD (CHILDREN'S ISLAND SANITARIUM).

OCT. 3, 1907.

To Miss LUCY W. DAVIS, *Superintendent, Children's Island Sanitarium, Marblehead, Mass.*

DEAR MADAM:—In response to your request of Sept. 10, 1907, for an examination of the drinking water supply of the Children's Island Sanitarium, in Marblehead harbor, the Board has caused the well indicated as the source of supply to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water is very hard, has a disagreeable odor and contains an excessive quantity of organic matter. It is unfit for drinking, and the Board would recommend that the further use of this source be prevented.

MARION.

OCT. 7, 1907.

To the Board of Selectmen of the Town of Marion.

GENTLEMEN:—The State Board of Health received from you on June 21, 1907, an application for advice with reference to a proposed water supply, to be taken from the ground at a point in the valley of Benson's Brook, so called, about half a mile northwesterly from the Marion railroad station and less than half a mile west of Front Street; and subsequently a pumping test was made by connecting together eight wells in the locality indicated and pumping from them continuously with a steam pump for a period of about ten days, from September 5 to September 15 last.

The Board has caused the locality to be examined by its engineer and has examined the results of observations upon the quantity of water pumped, the height of ground water in the various wells during the test, and the results of analyses of samples of water collected and sent in by you while the test was in progress.

The analyses show that the water pumped during this test was of very good quality for all of the purposes of a public water supply. The quantity drawn from the wells averaged nearly 450,000 gallons per day, but this water was discharged upon the ground so near the wells that some of it evidently re-entered the ground, and measurements made of the quantity actually flowing down the stream indicate that the net quantity of water yielded by this source during the test was probably in the neighborhood of 300,000 gallons per day.

Considering the various conditions affecting the test, and the evidence submitted as to the recovery of the wells after the test, it seems probable to the Board that this source cannot be depended upon in a very dry summer season to yield more than about 200,000 gallons per day, and the quantity obtainable may be considerably less than the amount indicated.

It is very difficult to estimate closely the quantity of water likely to be used during the summer months in a town like Marion, where there is a large increase in the population during the summer months. The experience in other similar towns shows that the increased use of water during that period may be a very large one, though, judging from the information furnished by you, it is unlikely to be as large in Marion as in some towns similarly situated.

It is probable that the consumption of water in Marion can be kept within reasonable limits if the works shall be carefully constructed, so as to avoid as far as practicable the loss of water by leakage from the pipes, and if provision is made in the beginning for metering all services, and also for measuring accurately the quantity of water delivered into the distributing system. By these means it would be practicable to detect unnecessary use or waste of water or loss of water by leakage, and they would aid greatly in keeping the consumption of water from becoming excessive.

If these conditions shall be observed it is probable, in the opinion of the Board, that enough water can be obtained from the ground in the locality in which the test was made to supply the town until the requirements for water have increased materially over what they are at present.

The test wells thus far driven are located in a swampy district, where the ground is covered by a considerable depth of peaty soil. While there is no evidence that the ground water at the present time is affected by this condition, the water in wells in similar situations has in many cases deteriorated after a longer or shorter period of use, and the Board would recommend that if permanent works shall be constructed for taking a supply of water for Marion from the ground in this locality the wells be placed in the upland above the edge of the swamp, and that the channel of the brook be kept clear, so that the flooding of the land in the neighborhood of the wells may be avoided, unless occasionally at times of freshet. It is also desirable, if final works shall be built in this locality, that the collecting works be extended over a much larger area than was covered by the test wells, to assist in maintaining the yield of the works in dry weather.

Dec. 5, 1907.

To the Board of Selectmen of the Town of Marion.

Gentlemen: — The State Board of Health received from you on Nov. 21, 1907, an application for the approval by this Board, under the provisions of chapter 268 of the Acts of the year 1907, of the taking by the town of Marion of certain parcels of land for preserving the quality of the sources of water supply of the town, accompanied by a plan and description of the lands which it is proposed to take.

The lands indicated have an aggregate area of about 14.5 acres, and include the wells from which it is now proposed to take water for the supply of the town of Marion. The Board has considered your application and the plan submitted therewith, and concludes that the area which it is proposed to acquire at the present time is necessary for the purpose indicated.

The Board hereby approves the taking of the lands shown on the plan accompanying the application, entitled "Marion Water Works. Plan of Land at Proposed Source of Water Supply in the Vicinity of Benson's Brook (so called). Scale: 40 feet to an inch. Nov. 15, 1907. Louis E. Hawes, Civil and Hydraulic Engineer, Boston."

The parcels of land to be taken are bounded, measured and described as follows: —

1. *Land of Jabez W. Handy.*

Beginning at a stone wall on the westerly side of Front St., where the stone wall on the division line between land of said Jabez W. Handy and land of Carrie W. Benson intersects said westerly wall of Front St., said starting point being 3 feet easterly on said division line from a stone bound; thence the line bounding this parcel of land runs S 75° 20′ 10″ W by land of Carrie W. Benson and a wall and fence about 360.0 feet to a pointed stone; thence N 16° 09′ 50″ W by land of Richard W. Clark 20.02 feet; thence N 76° 20′ 10″ E by land of said Handy about 360.17 feet to a wall on the westerly side of Front St., thence S 15° 39′ 50″ E by said wall on the westerly side of Front St. 20.01 feet to the point of beginning; comprising about .17 of an acre. This parcel constitutes a right of way 20 feet wide.

2. *Land of Richard W. Clark.*

Beginning at a pointed stone in the fence line on the boundary separating land of said Richard W. Clark from land of Carrie W. Benson, said point of beginning being about 360.0 feet on said boundary line from the stone wall on the westerly side of Front St.; thence the line bounding the parcel described runs S 76 ° 20 ′ 10 ″ W by land of Carrie W. Benson to the south, about 667.5 feet to a stake at the westerly end of the portion of this parcel which constitutes a right of way 20 feet wide; thence the line continues S 76 ° 20 ′ 10 ″ W by land of said Benson about 250.0 feet to an angle; thence S 76 ° 30 ′ 10 ″ W by land of said Benson about 180.1 feet to a stake and angle; thence S 76 ° 45 ′ 10 ″ W by land of said Benson about 284.4 feet to a stake and angle; thence S 76 ° 56 ′ 40 ″ W by land of said Benson about 173.0 feet to a stake and a corner; thence the line runs N 19 ° 48 ′ 5 ″ W by land of Richard W. Clark about 384.85 feet to a corner at land of Judah Hathaway; thence the line runs N 81 ° 26 ′ 43 ″ E by land of said Judah Hathaway on the north about 306.4 feet to Benson's Brook, so called, and land of Annie F. Gurney; thence the line continues N 81 ° 26 ′ 43 ″ E by land of said Annie F. Gurney on the north about 480.5 feet to a spike in a stump at a corner; thence the line runs S 38 ° 8 ′ 20 ″ E by land of said Richard W. Clark about 325.93 feet to a corner and the westerly end of the portion of this parcel which constitutes a right of way 20 feet wide, said corner being at the westerly end of the north line of said right of way; thence the line runs N 76 ° 20 ′ 10 ″ E by land of said Clark about 675.73 feet to a corner and land of J. W. Handy, this line is on the northerly side of the 20 ft. right of way; thence the line runs S 16 ° 9 ′ 50 ″ E by land of J. W. Handy 20.02 feet to pointed stone at the place of beginning on the division line between said Clark and Benson, which constitutes the southerly line of said 20 ft. right of way; the whole comprising about 6.97 acres, of which .31 acres is in the portion which constitutes the right of way aforesaid.

3. Land of Annie F. Gurney.

Beginning at a spike in a stump at the most northeasterly corner of proposed taking from Richard W. Clark, described herein and numbered 2, the line runs S 81 ° 26 ′ 43 ″ W along land of said Richard W. Clark on the south about 480.5 feet to Benson's Brook, so called; thence the division line follows the center of said Benson's Brook northwesterly by land of Judah Hathaway about 238 feet; thence N 81 ° 15 ′ 15 ″ E about 386.65 feet by land of said Annie F. Gurney to a stake; thence S 80 ° 19 ′ 35 ″ E about 316.4 feet by land of said Gurney to the point of beginning; comprising about .96 acres.

4. Land of Judah Hathaway.

Beginning at the center of Benson's Brook, so called, on the line separating land of said Judah Hathaway from land of Richard W. Clark and at the point which constitutes the westerly end of the line separating land of said Richard W. Clark from land of Annie F. Gurney as described herein under the parcel of land proposed to be taken from Richard W. Clark, said description being numbered 2; thence the line runs S 81 ° 26 ′ 43 ″ W by land of said Richard W. Clark about 306.4 feet to a corner, said corner being at the extreme northwest corner of said proposed R. W. Clark taking described herein, numbered 2; thence the line runs N 19 ° 48 ′ 5 ″ W by land of Judah Hathaway about 98.77 feet to a stake and corner; thence the line runs

N 81 ° 15 ′ 15 ″ E by land of said Hathaway about 119.0 feet to the center of Benson's Brook, so called, and land of said Annie F. Gurney and a corner; thence southeasterly by the center line of Benson's Brook, so called, and land of said Gurney about 238 feet to the point of beginning and land of Richard W. Clark; comprising about .5 of an acre.

5. *Land of Carrie W. Benson.*

Beginning at a point in a fence line separating land of Carrie W. Benson from land of Richard W. Clark and land of Jabez W. Handy, said point being about 1,027.5 feet on said fence line westerly from the stone wall in the westerly side of Front St., said point being also at the westerly end of a right of way 20 feet wide mentioned in the descriptions of proposed taking of land of Jabez W. Handy and of Richard W. Clark numbered herein respectively 1 and 2; thence the line bounding this parcel of land runs S 21 ° 57 ′ 20 ″ E by land of said Carrie W. Benson about 292.09 feet to a corner and land of E. Parton; thence the line runs S 76 ° 56 ′ 20 ″ W by land of said Parton about 380.09 feet to an angle; thence the line runs S 75 ° 2 ′ 7 ″ W by land of said Parton about 392.23 feet to a stake and angle; thence S 77 ° 26 ′ 25 ″ W by land of said Parton about 124.15 feet to a stake and corner, said stake and corner being 100 feet easterly from a stone bound located on a continuation of the last course; thence N 19 ° 48 ′ 5 ″ W by land of said Carrie W. Benson about 297.7 feet to a stake and corner at land of Richard W. Clark, said stake marking also the southwesterly extremity of a proposed taking from Richard W. Clark as described herein, numbered 2; thence N 76 ° 56 ′ 40 ″ E by land of Richard W. Clark described herein as a proposed taking and numbered 2, about 173 feet to a stake and an angle; thence N 76 ° 45 ′ 10 ″ E by land of said Clark about 284.4 feet to a stake and angle; thence N 76 ° 30 ′ 10 ″ E by land of said Clark about 180.1 feet to a nail in the fence and an angle; thence N 76 ° 20 ′ 10 ″ E by land of said Clark about 250 feet to a stake and corner at the point of beginning; the whole comprising about 5.95 acres.

MARION (GEORGE F. RICHARDS).

APRIL 4, 1907.

To MR. GEORGE F. RICHARDS, *Marion, Mass.*

DEAR SIR: — In response to your request for an examination of the water of a spring in Marion from which you propose to sell water for drinking, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water is of good quality for drinking purposes at the present time. The spring is located very close to a brook, and it is apparently possible under existing conditions for the brook water to find its way into the spring. By making provision for preventing brook water from entering the spring the water of the latter may safely be used for drinking.

MARLBOROUGH (METROPOLITAN WATER AND SEWERAGE BOARD).

JUNE 6, 1907.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The State Board of Health has received from Marcus M. Browne the following application for the approval of the location and construction of a slaughterhouse on his farm on Concord Road in the city of Marlborough: —

> The undersigned respectfully asks that he be granted a license to slaughter animals on the farm on Concord Road formerly known as the "Goodell" or "Brook's Farm."
>
> The request is made so that I may be able to slaughter our own animals and prepare them for use without being dependent on outside parties, as I am now forced to do. I intend to provide a place for slaughtering that will be clean and sanitary and can be kept so at all times.

The Board has considered the application and has caused the locality to be examined.

From the information presented it appears that the slaughterhouse is to be located on the summit of a ridge apparently composed of gravelly soil, and will be distant 400 feet or more from the nearest water course draining into the metropolitan water supply. The dimensions of the building are to be about 20 feet by 30 feet and a tight cellar is to be provided, lined with cement concrete to prevent the escape of wastes.

The Board hereby approves the location and construction of the proposed slaughterhouse at the point indicated to be used by the applicant, for the purpose and in the manner indicated in his application.

MAYNARD.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Sept. 5, 1907, for preventing the pollution and securing the sanitary protection of the waters of White Pond and its tributaries, used by the town of Maynard as a source of water supply.

MEDWAY.

NOV. 7, 1907.

To Messrs. JOHN P. HUNT, ROBERT M. O'DONNELL, GEORGE S. BENT, W. W. OLLENDORFF and H. W. SHAW, *Water Supply Committee of the Town of Medway.*

GENTLEMEN: — The State Board of Health received from you on Oct. 10, 1907, an application for advice relative to a proposed water supply for Medway, in which you state that the following sources are under consideration: ground water on the north side of the Charles River near Buckram Mill; ground water in territory near Populatic Pond, on the south side of Charles River: ground water on the southerly slope of Drybridge Hill; ground water in the neighborhood of Mine Brook, and surface water from Hopping Brook or Chicken Brook.

The Board has caused the sources of supply mentioned to be examined by its engineer and samples of waters from several of the sources to be analyzed.

The results of the examinations of Hopping Brook and Chicken Brook show that the waters of those streams are highly colored and contain much organic matter, and that their watersheds include a considerable population. Neither stream can be regarded as a desirable or safe source from which to take water directly for drinking.

The springs on Drybridge Hill are of far too limited capacity to furnish the quantity of water required by the town.

Mine Brook is badly polluted by domestic and manufacturing sewage in the town of Franklin, and would be an unfit source of public water supply if taken directly. The conditions are not favorable for obtaining a supply of ground water of good quality in the valley of this stream in the immediate vicinity of the village. Farther up stream the conditions are somewhat more favorable, but this locality is a less desirable one than others that are available.

The Buckram Mill is located very close to the village, and analyses of the waters of a spring and a tubular well in its neighborhood show that the ground water here is affected unfavorably by the nearness of the village. The water would also probably be affected by an excess of iron, which would make it objectionable for water-supply purposes, and both of these objections would be likely to increase if the quantity of water required by the town should be taken from the ground in this locality.

The region about Populatic Pond, especially on its westerly side, is a very favorable one, judging from surface indications, for obtaining water from the ground in large quantities. Except for a few summer camps this district is uninhabited, and it is probable that water of excellent quality could be obtained there with properly located works. While the areas favorable for obtaining ground water in this region are within the town of Franklin, they are, nevertheless, very close to Medway, yet not near enough to be affected by drainage therefrom, and, so far as can be judged from the examinations thus far made, this locality is the most favorable one of the places mentioned in which to seek a water supply for Medway.

It would be desirable to take water from some source within the limits of the town of Medway, but no place has been found where the conditions for obtaining ground water appear to be as favorable, so far as can be judged from surface indications, as in the locality near Populatic Pond.

The Board would advise as the next step in your investigations that you cause test wells to be sunk in the region near Populatic Pond, to determine the character of the soil and the probable quality and quantity of ground water to be obtained there. It is important that these further investigations be made with the assistance of an engineer of experience in matters relating to ground-water supplies, and the Board will assist you, if you so request, by making the necessary analyses of water, and will, upon application, give you further advice when you have the results of further investigations to present.

NEWBURY (DUMMER ACADEMY).

SEPT. 5, 1907.

To Mr. C. S. INGHAM, *Master, Dummer Academy, South Byfield, Mass.*

DEAR SIR: — In response to your request for an examination of the water of a well which it is proposed to use as a source of water supply for Dummer Academy, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water of this well is of excellent quality for drinking and other water-supply purposes. The well is located on the slope of a hill which at the present time is for the most part wooded and free from buildings, and so long as these conditions exist the water will doubtless continue to be safe for drinking.

NEWBURYPORT.

MARCH 9, 1907.

To the Board of Health of the City of Newburyport.

GENTLEMEN: — Recent analyses of the water now being supplied to the city of Newburyport show that it contains an excessive quantity of mineral matter and considerable organic matter derived chiefly from certain deep tubular wells which have recently been driven in the neighborhood of the pumping station.

It appears that, notwithstanding that you were advised, in a communication dated Dec. 7, 1905, as to the poor quality of the water of the tubular wells in this neighborhood at that time, additional deep tubular wells have since been put in, and that these wells furnish water of very much poorer quality, containing not only much iron but so much other mineral matter as to render the water objectionable for many uses, and probably injurious to health if used for drinking.

It is evident also that the quantity of water that can be obtained from all of the various sources of water supply available for use by the city at the present time is insufficient for its requirements. There does not appear to be any source from which it is practicable to obtain a temporary supply of water of good quality to meet the present emergency, but it is probable that an increased flow of water, due to the thawing of the ground and melting of snow, will make it practicable to discontinue very soon the use of the more objectionable of the sources from which water is now drawn.

The Board would again recommend that measures be taken without delay to provide a sufficient supply of good water for the city, so that the use of the objectionable water from your present sources may be discontinued. When a new source is available the deep tubular wells should be closed, and their waters prevented from affecting the other sources if possible. Changes should also be made in the connections at the pumping station, so that only water from the covered wells and springs which is of good quality may be supplied to the city without mingling with the water of the open basin.

The importance of taking up the work of providing an additional supply without delay cannot be too greatly emphasized, since it is evident from your experience of this winter that your present sources are not capable of furnishing enough water of the very inferior quality which they now furnish to meet the requirements of the city at all times.

Your further investigations should be made with the assistance of an engineer of experience in matters relating to ground-water supplies and should be begun without delay, so that the construction of the necessary works may be begun at as early a date as practicable in the coming spring.

The Board will assist you in further investigations by making the necessary analyses of water, and will advise you as to the use of water from any source which you may have under consideration, if you so request.

April 25, 1907.

To the Board of Water Commissioners of the City of Newburyport.

Gentlemen: — The State Board of Health received from you on March 13, 1907, a communication requesting an examination by the Board of the locality known as "Common Pasture," and advice as to the practicability of obtaining water of good quality for domestic purposes from the ground in that region, and in sufficient quantity for the supply of the city in connection with the present works.

In response to this request the Board has caused the locality to be examined by its engineer and a sample of the water from one of the test wells driven in this valley several years ago to be analyzed, and has considered the records of previous tests made, with a view to obtaining a water supply for Newburyport in this locality.

The tests thus far made in the Common Pasture and its neighborhood indicate that there is an extensive stratum of gravel beneath the clay surface of this area from which water can be drawn quite freely, but that this gravel stratum is very thin, and the reports of the results of pumping tests are unfavorable for obtaining continuously any very large quantity of water from the ground in this region.

Analyses of samples of the water from three different wells or groups of wells in the Common Pasture collected in 1894, and a sample from one of them collected recently, indicate that the ground water in this region is very hard, and objectionable on this account for water-supply purposes. There are indications, also, that the water in parts of this region may be affected by the presence of an excess of iron.

Considering the circumstances it does not seem advisable for the city to make further tests in the Common Pasture with a view to obtaining an auxiliary water supply there.

Judging from the results of a general examination, the conditions for obtaining a large supply of ground water of good quality are more favorable in the region south and west of your present sources of supply than elsewhere within the limits of the city of Newburyport. It is evident from an examination of the contour of this territory that much of the water falling upon the ground sinks into the soil and finds an outlet in the form of springs into the neighboring water courses. Part of this water doubtless finds its way to the springs from which your present water supply is obtained, but it is probable that much of it finds outlets in other directions.

While it is said that tests of the ground south of your present works, made with a view to obtaining ground water, have not given favorable results, the records of these tests are not available, and the results, in view of the character of the soil and the contour of the territory, cannot be regarded as conclusive. In the opinion of the Board the conditions here are more favorable for obtaining a large supply of good water from the ground than at any other of the localities that have been examined within the limits of the city.

The Board is unable to advise you as to whether it would be more economical for the city to secure an additional supply by taking water from the ground in the region indicated than by the plan of pumping water from the Artichoke River and filtering it through the ground or through artificial filters into your present sources, but the cost of the Artichoke River plan is likely to be materially increased if the intake shall be placed a mile or more further up stream than was proposed in the plan presented in 1903; and if ground water can be obtained in large quantity from the region south or southwest of your present works, it is not improbable that the cost of works for obtaining an additional supply in this way would be less than by the use of the Artichoke River.

If you should decide to make further tests with a view to obtaining ground water in the region south and southwest of your present sources the Board will, if you so request, make the necessary analyses of water and will give you further advice when the results of the tests are available.

Aug. 1, 1907.

To the Board of Water Commissioners of the City of Newburyport, Mr. Charles A. Bliss, *Chairman.*

Gentlemen: — The State Board of Health received from you on July 2, 1907, a communication stating that test wells had recently been driven in the Common Pasture territory, from which water was then being pumped, and requesting approval of the plan of pumping this water into the supply mains of the city and using it in connection with the water of the regular sources.

The Board has caused the locality in which the wells are driven to be examined by its engineer and samples of water collected while pumping from these wells to be analyzed. The results of the analyses are very similar to the results of previous analyses of samples of water collected from test wells in this locality. They show that the water obtainable from the ground in the Common Pasture is very hard, and to this extent objectionable for water-supply purposes. The presence of an excessive quantity of nitrites and the absence of oxygen indicates that the quality of the water is likely to change, the effect of which might be to make it still further objectionable by the presence of an excessive quantity of iron. Very little increase in the quantity of iron has been noted as yet.

The quantity of water pumped from the wells during the last three weeks of the test has averaged about 300,000 gallons per day. Observations of the height of water in wells at distances of from 800 to 2,000 feet from the pump show that the pumping from the wells now in use affects the ground water over a very large area, and, considering this fact and the limited thickness of the stratum from which water is obtained, the indications for obtaining continuously a much larger quantity of water from the ground in the Common Pasture than is now being drawn from the wells are not favorable. In a dry period the yield is likely to be much smaller.

Considering the results of the pumping test, the Board is unable to consent to the taking of water from the Common Pasture source as a permanent supply for the city of Newburyport. It is evident, however, that the total quantity of water obtainable from your present sources is likely to prove insufficient for the supply of the city, and analyses of the water show that the quality of that furnished by certain of the tubular wells is much more objectionable than that now being drawn from the wells in the Common Pasture. There appears to be no way of obtaining immediately an additional supply of good water for the city as a substitute for the very objectionable water of certain of the tubular wells now used, and, since it is better to use the less objectionable of the available sources, the Board approves the use of the water from the wells in the Common Pasture as a temporary supply, to relieve the present emergency, and recommends that the use of water from the deep tubular wells near the pumping station be discontinued as soon as possible. Only so much water as may be necessary to meet the requirements of the city in addition to the yield of the remaining sources should be drawn from the wells in the Common Pasture.

In introducing water from wells in the Common Pasture for the temporary use of the city it would be desirable to mix this water thoroughly with the waters drawn from the present sources of supply before delivering it to consumers, if such an arrangement is practicable, since otherwise there will be portions of the city in which the hardness of the water will vary greatly from time to time, a condition which it is desirable to avoid if possible.

The right to use water from the Common Pasture territory, taken under the provisions of chapter 25, section 35, of the Revised Laws, will terminate with the end of the present year; and it is very important that in the mean time an adequate supply of water be obtained for the city from some suitable source.

In a communication of the Board on April 25 reference was made to the region south and west of your present sources of supply, where the conditions for obtaining a large quantity of ground water appear to be more favorable than elsewhere within the limits of the city. If, before carrying out the plan of taking water from the Artichoke River, the city desires to make tests in the region indicated, such tests should be begun at once in order that there may be as little further delay as possible in the selection of a source of water supply for the future use of the city.

NEWBURYPORT (CHASE-SHAWMUT COMPANY).

OCT. 3, 1907.

To the Chase-Shawmut Company, Newburyport, Mass., MR. B. S. LUTHER, *Superintendent.*

GENTLEMEN: — In response to your request of Sept. 17, 1907, for an examination of the water of a well used for the supply of your factory, the State Board of Health has caused the well to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water, while somewhat hard, is of good quality for drinking, and an examination of the well shows that there are no sources of pollution in its neighborhood at the present time.

While the conditions remain as at present the Board is of the opinion that the water of this well may safely be used for drinking.

NORTHAMPTON (HOLYOKE STREET RAILWAY COMPANY).

OCT. 3, 1907.

To the Holyoke Street Railway Company, Holyoke, Mass.

GENTLEMEN: — The attention of the State Board of Health has been called to the condition of the water supplied to the hotel on the top of Mount Tom, which the Board is informed is maintained by your company, and the Board has caused an examination of the sources of supply to be made by one of its engineers and samples of their waters to be analyzed.

The water supply of the hotel is drawn in part from springs on lands adjacent to the hotel grounds, near the top of the mountain, supplemented usually during most of the summer season by water drawn from a reservoir near by. At times, when the supply is being drawn from the reservoir, drinking water for the guests of the hotel is taken from springs near the foot of the mountain, on its southeasterly side. At the time the examination was made water was being supplied to the hotel from the reservoir on the top of the mountain, the quantity furnished by the springs there being insufficient for the requirements of the hotel.

The results of the analysis of the water supplied to the hotel from this source show that it contains an excessive quantity of organic matter and is unfit for drinking or other domestic purposes.

The water of the springs or wells near the foot of the mountain is naturally of good quality for domestic purposes, but the waters of these sources are not properly protected from danger of pollution, and there is further danger of the pollution of this water by handling in the course of its transportation to the hotel.

The Board would recommend that a supply of good drinking water be provided for the use of visitors to the mountain.

NORTH ATTLEBOROUGH (W. G. CLARK & CO.).

JULY 9, 1907.

To W. G. CLARK & CO., *North Attleborough, Mass.*

GENTLEMEN: — In response to your request for an examination of the water of a well at your factory in North Attleborough, from which you desire to supply water to the operatives for drinking, the Board has caused the well and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water is very badly polluted and is unfit for drinking; and the Board recommends that measures be taken for preventing the use of this water for that purpose.

NORTHFIELD (NORTHFIELD SCHOOLS).

Nov. 7, 1907.

To Mr. A. G. MOODY, *The Northfield Schools, East Northfield, Mass.*

DEAR SIR: — In response to your request for an examination of your present sources of water supply, and of certain others from which it is desired to take water at times when the regular sources are inadequate, the Board has caused the present and proposed sources of supply to be examined by one of its engineers and samples of their waters to be analyzed.

The watershed of the reservoir on Louisiana Brook, from which your supply is mainly drawn, is uninhabited, and the quality of the water, as shown by a recent analysis, is satisfactory for water-supply purposes. The yield of this source is inadequate for the requirements of the population supplied.

The springs on the westerly slope of Strobridge Hill, used to supply a number of dwelling houses in their neighborhood, supply water which is naturally of good quality for water-supply purposes; but there are several dwelling houses near the springs, and, as they are not covered or protected from the entrance of surface water, there is danger that they may be polluted by the population living in their neighborhood.

If the use of the springs is to be continued they should be thoroughly covered and protected from the entrance of surface water or matters which might carelessly be thrown or deposited in them or upon the ground in their neighborhood. It appears that house lots have been laid out upon land above the springs, and if these should be built upon the danger of the pollution of these sources would be greatly increased, and it would probably be necessary to discontinue their use.

Of the proposed sources of additional supply mentioned in your application, the spring in the glen near Louisiana Brook will, under present conditions, furnish water of good quality for water-supply purposes. This spring also should, if it is to be used as a source of water supply, be protected in the manner already suggested for the springs on the side of Strobridge Hill.

Louisiana Brook in its lower section is seriously polluted at the present time by sewage from dwelling houses in its neighborhood, and, in the opinion of the Board, is an unsafe source from which to take water for drinking.

The present sources of supply, together with the spring near Louisiana Brook, cannot, in the opinion of the Board, be depended upon to furnish an adequate quantity of water for the requirements of the population of the schools and the buildings about them in the summer season, when a much larger quantity of water is required than ordinarily; and the Board would recommend that you take measures, without delay, to secure an additional supply of water of good quality sufficient at all times for the requirements of the schools and buildings in their neighborhood to which water is now supplied.

In making investigations as to an additional water supply the Board would advise that you secure the assistance of an engineer of experience in matters relating to water supply. The Board will assist you in further investigations by making the necessary analyses of samples of water, and will, upon request, give you further advice when you have the results of further investigations to present.

PALMER (BONDSVILLE).

DEC. 9, 1907.

To the Boston Duck Company, Bondsville, Mass.

GENTLEMEN: — The attention of the State Board of Health has been called to certain sources from which water is supplied for drinking and other purposes in the village of Bondsville by works which the Board is informed are under the control of your company, and the Board has recently caused these sources to be examined by one of its engineers and samples of their waters to be analyzed.

One of the sources is a large well on the side of a hill about 350 feet from the mill. The water from this well is said to be piped to the mill and several houses in the village for use for drinking, and the results of an analysis show that the water is grossly polluted and unfit for drinking purposes, and the Board recommends that its further use be prevented at once.

The other source is the canal above the mill, from which it appears that water is supplied for general purposes to the factory buildings and a large number of tenements in the village. This canal receives its water from the Swift River, which drains an area of nearly 200 square miles, containing a population of several thousand. Within a distance of 8 or 9 miles the river receives a considerable quantity of sewage and manufacturing wastes from mills along the stream, and, in the opinion of the Board, this water is likely to injure the health of those who use it for drinking. While it may be necessary to continue the use of this source until a proper water supply for the village can be provided, the Board recommends that the persons to whom it is supplied be notified that it is dangerous for drinking, and that notices to that effect be posted at all points in the mills and elsewhere where water from the pipes of this system is accessible to mill operatives and the public for drinking.

A supply of good drinking water should be provided in this village as soon as possible. In the mean time all persons to whom the waters from these sources are supplied should be notified that they are unsafe for drinking unless they have been boiled for at least fifteen minutes. The boiled water should be handled with care, and danger of its pollution after boiling carefully avoided.

The Board recommends that a source of water supply which will furnish water of good quality for drinking and other domestic purposes be secured as soon as possible and used for the supply of your mills and tenements, and that the use of the polluted water of the present sources be permanently discontinued.

DEC. 9, 1907.

To the Board of Health of the Town of Palmer.

GENTLEMEN: — The attention of the State Board of Health having been called to the character of the water supplied to mill operatives and inhabitants of the village of Bondsville, in Palmer, the Board has caused the sources of supply indicated to be examined by one of its engineers and samples of their waters to be analyzed. The results show that the water of one of the sources, a spring about 350 feet from the factory of the Boston Duck Company, is grossly polluted and unfit for drinking, while the other source, a canal leading from the Swift River, is also seriously polluted, so that the water is unsafe for drinking. These sources appear to be under the control of the Boston Duck Company, and that company has been informed of the conditions there in a communication of this date, a copy of which is enclosed herewith.

A third source of water supply in Bondsville was also examined at the time the other sources were investigated. This source is a well located at the junction of two highways, about 300 feet southwest of the railroad station on the Massachusetts Central Railroad. The analysis of a sample of this water shows that it is badly polluted and unsafe for drinking, and the Board recommends that its further use for this purpose be prevented.

In the opinion of the Board, it is very important, for the proper protection of the health of the inhabitants, that a supply of water of good quality for drinking and other purposes be provided in this village.

PITTSFIELD.

JULY 9, 1907.

To the Board of Public Works of the City of Pittsfield.

GENTLEMEN: — The State Board of Health received from you on April 22, 1907, an application for advice with reference to proposed plans for enlarging and improving the water supply of Pittsfield, which provide for constructing a new reservoir, holding about 22,000,000 gallons, on Ashley Brook, at a higher elevation than the present intake reservoir on that stream, for diverting into this reservoir the waters of Sacket and Hathaway brooks by means of an Akron pipe conduit, and for constructing a new intake reservoir on Mill Brook at a higher level than the present reservoir. Subsequently, further plans were submitted, showing the results of an investigation with reference to the diversion of water from the watershed of Roaring Brook into that of Mill Brook, and for the construction of a storage reservoir in the valley of the latter stream, from which it appears that it is practicable to construct a dam on the southerly arm of Mill Brook and to create there a reservoir having a capacity of about 150,000,000 gallons, into which the waters of the northerly tributaries of Roaring Brook, having an aggregate watershed of somewhat more than 3 square miles, can be diverted by gravity.

The Board has caused the proposed sources to be examined by its engineer and samples of their waters to be analyzed, and has considered the plans presented. The plan of constructing new intake reservoirs on Ashley and Mill brooks, at higher levels than the present reservoirs, will make it practicable to increase the pressures in the city, and, while small portions of the watersheds of these streams will cease to be available, the proposed new intake reservoirs will store much larger quantities of water, thus tending to increase somewhat the dry-weather yield of the streams.

The waters of Sacket and Hathaway brooks will have to be intercepted at a considerably higher level than the present intake reservoirs on those streams in order to divert these waters into the proposed new Ashley Reservoir, and a portion of these watersheds will cease to be available under the new plans. If Akron pipe should be used in the construction of the proposed conduit a further considerable loss of water might occur, and, in the opinion of the Board, it would be better to construct this conduit of iron or steel pipe with tight joints instead of Akron pipe, so as to avoid danger of the further loss of water by leakage.

The proposed new storage reservoir on Mill Brook appears to be an excellent one for the storage of water, and if properly prepared for the purpose by the removal of all soil and organic matter from the area flowed, the water stored therein will not deteriorate.

The water of the main stream of Roaring Brook, above the point at which it might be diverted by gravity into Mill Brook, is highly colored and contains a large quantity of organic matter, and would probably be objectionable if supplied directly to the city, even after storage in the proposed Mill Brook Reservoir.

An examination of the tributaries of Roaring Brook shows that the lower tributaries nearest to Mill Brook contain water which is not highly colored and is low in organic matter, and this water, if diverted into the proposed new storage reservoir on Mill Brook, and the latter is suitably prepared for the purpose, will undoubtedly be of satisfactory quality for drinking and other domestic purposes. Of the two principal tributaries of Roaring Brook which flow into Clapp Pond the larger contains water which is quite highly colored, owing to contact with vegetable matter in swamps adjacent to the stream. The fall of this stream is large, and it would apparently be practicable without serious difficulty or expense to lower materially the channel of the brook and drain the adjacent swamps, thereby greatly reducing the color of the water by preventing it from standing for long periods in contact with the organic matter of the swamps. The water of the southerly and smaller tributary of Clapp Pond has less color than the larger one, but this water could also doubtless be greatly improved in quality by draining swamps adjacent to the brook. A third and much smaller tributary of Clapp Pond contains water which has very little color.

It will probably not be necessary to extend the intercepting conduit to these upper tributaries in the beginning, and it will doubtless be practicable to drain these swamps thoroughly before the waters of these streams are required for the use of the city. Care will be necessary in constructing the conduit to divert the waters of these tributaries into Mill Brook to place it below the level of the ground water wherever practicable, so as to secure all the yield possible from the watershed of Roaring Brook, and where it is impracticable to lay the conduit below the level of the ground water — or where, if so laid, the water admitted might be objectionable — the conduit should be laid with tight joints, so as to prevent leakage or exclude objectionable water.

PLAINVILLE.

JULY 9, 1907.

To the Board of Health of the Town of Plainville.

GENTLEMEN: — The attention of the Board has again been called to the condition of the pond in the village of Plainville from which water is supplied to several dwelling houses for domestic purposes, and the Board has caused a further examination of the pond and its surroundings to be made by one of its engineers.

This examination shows that the watershed of the pond in question contains a large population, much of which is located in the immediate vicinity of the pond or the stream which feeds it, which renders the water unsafe to use for drinking. The Board would recommend that those to whom this water is supplied should be warned of the danger of its use, and that a supply of uncontaminated water be introduced into the village as soon as practicable.

PLYMOUTH (SPRING AND WELL).

AUG. 1, 1907.

To the Board of Health of the Town of Plymouth, MR. HARRY B. DAVIS, *Secretary.*

GENTLEMEN: — In response to your request of July 13, 1907, the Board has caused the Elder Brewster Spring and the well at the factory of Ripley & Bartlett on Water Street in Plymouth to be examined and samples of the waters of those sources to be analyzed.

The analysis of the water of the Elder Brewster Spring shows no material change since the previous analysis was made, and the water may still be considered safe for drinking.

The water of the well of Ripley & Bartlett is of much the same character as that of the Elder Brewster Spring, and the analysis indicates that this water also is at present safe for drinking.

PROVINCETOWN.

MARCH 9, 1907.

To the Board of Water Commissioners of the Town of Provincetown.

GENTLEMEN: — The State Board of Health has considered the results of the further tests that you have made recently with a view to obtaining a water supply for Provincetown from the ground near North Truro, and has caused the locality to be examined by one of its engineers.

The tests have consisted in pumping water for a period of a little over a week from a series of eight tubular wells, connected to a steam pump and located about 1½ miles northeast of North Truro and 500 feet from the salt marsh known as Moon Pond Meadow.

It appears from the information furnished by you that the average quantity of water pumped was about 170,000 gallons per day, and that pumping had very little effect in lowering the ground water in the region.

The results of analyses of samples of water collected and sent in by you during the test, including one collected by an engineer from this office, show that the water is clear, colorless and odorless, free from an excess of iron and is in all respects a water of excellent quality for domestic purposes.

The Board sees no reason to doubt that water of excellent quality in sufficient quantity for the requirements of Provincetown can be obtained from the sandy lands in the region in which this test was made, and it is unlikely, with a proper location and maintenance of the wells, that the quality of the water would deteriorate in the future.

While the cost of the necessary works for obtaining water from North Truro and conveying it to Provincetown would be greater in the beginning than the cost of works for purifying the water of your present sources of supply, it is probable that a supply of water from North Truro would in the long run be the more economical and the quality of the water more satisfactory.

Considering the circumstances, the Board is of the opinion that the best plan of procuring a satisfactory water supply for the town of Provincetown will be to take water from the ground in North Truro in the region in which the recent tests have been made.

Nov. 7, 1907.

To the Board of Water Commissioners, Provincetown, Mass.

Gentlemen: — The State Board of Health received from you on November 1 an application for its approval, under the provisions of chapter 483 of the Acts of the year 1907, of the taking of water for the supply of Provincetown from the ground in the northerly part of the town of Truro, near the point where the highway from Truro to Provincetown crosses the railroad, accompanied by a report of your engineer containing information as to the results of a pumping test made by pumping water with a steam pump for a period of about three days from a group of six test wells in the locality indicated.

The Board has caused the locality to be examined by its engineer and samples of water sent in by you during the pumping test to be analyzed, and has considered the information presented.

The results of the test indicate that an ample supply of water for all the requirements of Provincetown can be obtained from the ground in the locality indicated, and the results of the analyses show that the water is of excellent quality for water-supply purposes. It is desirable to put in a larger number of wells than was connected with the pump during the test, and while it is improbable that the ground water in this region would be affected by the infiltration of sea water if a quantity not greater than that now used by Provincetown should be drawn from the wells in this region, it is probable that the amount of water used by the town will increase in the future, and, in the opinion of the Board, it is important, as you have suggested, to locate the wells farther up the valley than those used during the pumping test.

The Board hereby approves the taking of water for the use of Provincetown from the region described in the application, in the northerly part of the town of Truro.

Revere (Metropolitan Park Commission).

Oct. 3, 1907.

To the Metropolitan Park Commission, Boston, Mass.

Gentlemen: — In response to a request from Mr. H. W. West, superintendent of Revere Beach, for an examination of the water of a system of driven wells used for various purposes, including the supply of drinking-water fountains along the beach, the Board has caused the wells and their surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The wells are located very close to the sea, in a densely populated neighborhood. The results of the analysis show that the water contains much organic matter and chlorine, and is excessively hard and unsuitable for drinking, and the Board would recommend that its use for this purpose be discontinued.

ROWLEY (WELL OF W. C. FOSTER'S SONS).

MAY 2, 1907.

To the Board of Health of the Town of Rowley, MR. GEORGE B. PRIME, *Secretary.*

GENTLEMEN: — In response to your request for an examination of the water of the well at the shoe shop of W. C. Foster's Sons, and advice as to its quality, the Board has caused the well to be examined and samples of its water to be analyzed.

The results of the analyses show that the water has at some time been considerably polluted and not thoroughly purified in its subsequent passage through the ground before entering the well, the quantity of organic matter present being considerably larger than is found in good well waters.

The well is located in front of the factory, beneath the edge of the highway, from which it is probable that some of the pollution is derived, though there are other sources of pollution at no great distance, and, in the opinion of the Board, the source cannot be regarded as a safe one from which to take water for drinking.

SEEKONK (WELLS).

NOV. 7, 1907.

To the Board of Health of the Town of Seekonk.

GENTLEMEN: — In response to a request from Dr. Adam S. MacKnight, the State inspector of health of Health District No. 2, the State Board of Health has caused an examination to be made of three wells on the farm of John L. Baker in Seekonk, and samples of the water of these wells to be analyzed.

The wells are located close to the farm buildings, with sources of pollution close by, and the analyses show that all of them are very badly polluted.

The Board would recommend that the further use of these wells for drinking or other domestic purposes be discontinued.

SHARON.

FEB. 11, 1907.

To the Committee on Water Supply of the Town of Sharon, MR. WILLIAM L. HASKEL, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on Jan. 30, 1907, an application requesting the consent of the Board, under the provisions of chapter 91, section 2, of the Acts of the year 1905, to the taking, as a source of water supply for the town of Sharon, of the water from wells in the valley of Beaver Hole Meadow Brook, about 3,000 feet above the present pumping station, where a test of the quantity and quality of water obtainable has recently been made, concerning which you submit the following information: —

Eight $2\frac{1}{2}$ inch wells, 40 feet apart, in a straight line, were driven in the meadow to a depth of 21 to 33 feet, at the point at which Mr. Percy M. Blake, in his report to us of June 19, 1906, recommended that an additional supply of water for the town of Sharon should be taken, that is, a little over half a mile above the present pumping station. A copy of Mr. Blake's report has already been filed with your Board.

These wells were pumped by a steam pump from January 10 to 24 inclusive, with the exception of a break-down on the 16th, which lasted two days. The eight wells yielded about 500,000 gallons each day of twenty-four hours, with little variation during the day and no continued diminution of the flow at any time. The water in four open test wells in the vicinity, from 16 to 235 feet distant, was lowered from 5 inches to 2 feet 9 inches, and recovered promptly when pumping stopped. A natural spring 12 feet from the line of wells was lowered about 8 inches. An open test well 1,000 feet north, or down the valley, was not affected. A representative of your Board inspected the work, and samples of the water were forwarded to you daily for analysis. Samples have also been sent you from each end of the line of wells separately, together with a sample of Beaver Hole Meadow Brook at this point and of the spring previously referred to.

The Board has considered the information presented and has caused the locality to be examined by one of its engineers, and samples of water collected from the test wells during the recent pumping test to be analyzed.

All of the wells penetrated a stratum of gravel from which water could be pumped very freely, and, judging from the records of the quantity of water pumped during this test, there appears no reason to doubt that an ample supply for the requirements of Sharon can be obtained from the ground at this place.

The results of the analyses of samples collected during the test show that the water is of good quality for all the purposes of a public water supply.

Most of the test wells were located in the upland adjacent to the meadow bordering Beaver Hole Meadow Brook, but the wells at the southerly end of the line were located in the meadow and were sunk through about 10 feet of peaty soil before entering the underlying sand and the stratum of gravel from which the water was obtained. The sample collected while pumping from these southerly wells only showed the presence of a greater quantity of iron and organic matter than was found in the water pumped from the more northerly wells when the southerly wells were shut off.

It has been the experience that wells sunk through peaty soil become unfavorably affected, after a longer or shorter period of use, by the presence of iron. It is unnecessary in this case to locate wells in the meadow bordering the brook, since, without serious difficulty, they can be located in the neighboring upland, and the Board would recommend that they be placed as much as 100 feet back from the edge of the meadow if practicable.

The Board consents to the taking of water from the ground in the locality in which this test was made. Under the provisions of chapter 91 of the Acts of the year 1905 it will be necessary for you to submit the location of all wells for the approval of the Board.

SHELBURNE (F. C. ROWLAND).

DEC. 9, 1907.

To MR. F. C. ROWLAND, *Shelburne Falls, Mass.*

DEAR SIR: — In response to your request of Sept. 18, 1907, for an examination of the water of a spring from which it is proposed to supply water for domestic purposes to 12 or 15 families in Shelburne Falls, the Board has caused the spring and its surroundings to be examined by one of its engineers and samples of its waters to be analyzed.

The results of the analyses of samples of water collected at different times from September 24 to November 12 indicate that the water of the spring has been somewhat polluted, and it contained, at the time of the last examination, a larger quantity of organic matter and a larger number of bacteria than are found in good spring waters.

If this source is the only supply now available, the Board would recommend that the water be boiled for at least fifteen minutes before being used for drinking.

The most recent analysis shows also that the water takes up lead in small quantities in its passage through the lead pipe through which it is proposed to supply the water, and if this action should increase the quantity of lead may become great enough to cause lead poisoning. Boiling the water will not remove the lead, but, on the contrary, tend to concentrate it.

It is possible that the quality of this water may improve and its action on lead pipe decrease after water has been allowed to waste from the spring through the pipe for a considerable time; and the Board will, if you so request, make a further examination of the water next spring, after the period of highest flow in springs and streams, and advise you whether such improvement has taken place in its quality that the water may be regarded as safe for use.

SOMERSET (WELLS).

Nov. 7, 1907.

To the Board of Health of the Town of Somerset, MR. FRANKLIN S. SIMMONS, *Chairman.*

GENTLEMEN: — In response to a communication received Oct. 19, 1907, stating that an epidemic of typhoid fever has occurred in Somerset village, and requesting an examination of the water of certain private wells, the Board has caused an examination to be made of the wells located at the houses of Nicholas Powers, Eber Ray, Sarah A. Hood, Franklin Simmons, George H. Melvin, and of a well located near the New York, New Haven & Hartford Railroad at the foot of Old Colony Avenue, known as the "railroad" well, and samples of their waters to be analyzed.

The results of the analyses show that the water entering all of these wells has been very badly polluted by sewage and not thoroughly purified in its passage through the ground before entering the wells. The numbers of bacteria were high in the waters of most of the wells, and in some of them bacteria characteristic of sewage were found to be present.

In the opinion of the Board, the further use of the waters of any of these wells, with the exception of that near the house of Franklin Simmons, should be prevented. The water of the well of Franklin Simmons, though badly polluted, was evidently, at the time this examination was made, being quite well purified in its passage through the ground before entering the well, and in its present condition may not be unsafe for drinking, but changes in the circumstances affecting its pollution may at any time render this water unsafe, and the Board cannot recommend its continued use.

The results of the examinations show that there is very great need of a general water supply in this village, and the Board would recommend that the town take measures without delay to introduce a public water supply from some suitable source.

STONEHAM (WELL OF C. L. BOURNIVAL).

OCT. 3, 1907.

To the Board of Health, Stoneham, Mass.

GENTLEMEN: — In accordance with the request of Mr. C. L. Bournival for an examination of a well at 18 Mansion Street, Stoneham, and advice as to the quality of the water, the State Board of Health has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water of this well contains an excessive quantity of mineral matter, evidently derived largely from sewage deposited upon the ground about it, and in the opinion of the Board the water of this well is unsafe for drinking, and its further use should be prevented.

It appears to be practicable, by laying a not very long pipe line, to supply these tenements from the public water works, and the Board would recommend that this be done with as little delay as possible.

STONEHAM (WELL OF HEALEY BROTHERS).

NOV. 7, 1907.

To the Board of Health of the Town of Stoneham, MR. GEORGE A. HINCHCLIFFE, *Secretary.*

GENTLEMEN: — In response to your request of Oct. 14, 1907, for an examination of the water of a well used as a source of drinking-water supply at the factory of Healey Brothers in Stoneham, and advice as to its quality, the Board has caused the well and its surroundings to be examined and samples of the water to be analyzed.

The results of the examination show that there is a privy vault within a few feet of the well, and analyses show that the water is badly polluted and contains an excessive number of bacteria. The Board would recommend that the further use of this well be prevented.

One of the supply mains of the town water system is laid within a short distance of this factory, and the factory could apparently be supplied from the public works without serious difficulty.

SWAMPSCOTT (GEORGE D. R. DURKEE).

JAN. 25, 1907.

To MR. GEORGE D. R. DURKEE, *Swampscott, Mass.*

DEAR SIR: — In response to your request the State Board of Health has considered the plan for filtering the water of Moose Hill Spring in Swampscott, submitted by your engineer, Mr. Robert Spurr Weston, which provides for pumping the water into a 500-gallon tank and applying it to a filter 6 feet in diameter, designed to operate at a rate of about

4,000,000 gallons per acre in twenty-four hours, or less than 2,000,000 gallons per acre if operated for ten hours, with certain automatic arrangements for controlling the rate of filtration.

The water of this spring could, in the opinion of the Board, be purified by the proposed filter if it should be constructed with sand of a suitable degree of fineness and operated at rates not exceeding 2,500,000 gallons per acre per day.

In the opinion of the Board it is not advisable to use this spring as a source of drinking-water supply. While the water might be purified and made safe for drinking by filtration, it would still remain true that the purity of the water would be subject to any mischance that might occur in operating the filters.

SWAMPSCOTT (J. M. BASSETT).

JAN. 25, 1907.

To MR. J. M. BASSETT, *Swampscott, Mass.*

DEAR SIR: — In response to your request the State Board of Health has considered the plan for filtering the water of Bassett Spring, so called, in Swampscott, submitted by your engineer, Mr. Robert Spurr Weston, which provides for drawing the water into a 1,000-gallon tank and applying it to a filter 6 feet in diameter, designed to operate at a rate of about 4,000,000 gallons per acre in twenty-four hours, or less than 2,000,000 gallons per acre if operated for ten hours, with certain automatic arrangements for controlling the rate of filtration.

The water of this spring could, in the opinion of the Board, be purified by the proposed filter if it should be constructed with sand of a suitable degree of fineness and operated at rates not exceeding 2,500,000 gallons per acre per day.

In the opinion of the Board it is not advisable to use this spring as a source of drinking-water supply. While the water might be purified and made safe for drinking by filtration, it would still remain true that the purity of the water would be subject to any mischance that might occur in operating the filters.

JAN. 25, 1907.

To the Board of Health of the Town of Swampscott.

GENTLEMEN: — An application has been made by Messrs. George D. R. Durkee and J. M. Bassett for advice as to the use of water from Moose Hill and Bassett springs after filtration through sand. Neither spring is a desirable source of drinking water, though the Bassett Spring is the less objectionable of the two.

In the opinion of the Board it is not advisable to use these springs as sources of drinking-water supply, and while these waters may be purified and made safe for drinking by filtration through sand filters constructed of suitable material, it still remains true that the purity of the water will be subject to any mischance that may occur in operating the filters.

WALTHAM.

MARCH 7, 1907.

To the Hon. JOHN L. HARVEY, *Mayor, Waltham, Mass.*

DEAR SIR: — The State Board of Health received from you on March 1, 1907, the following communication, requesting its advice as to a proposed plan for constructing a large well north of Charles River and east of South Street in Waltham, for the purpose of obtaining an additional supply of water in order to reduce the draft from the present well: —

> Pursuant to your advice of Dec. 7, 1905, given in reply to my communication of Oct. 16, 1905, concerning an additional source of water supply, the city of Waltham has carried on its investigations in the neighborhood of South Street in the immediate vicinity of the wells used in the former pumping test, to which reference is made in your advice. We obtained immediately adjacent to these wells a lease for water-supply purposes from the Metropolitan Park Commission of approximately 2½ acres of land. On that several test wells have been sunk and the results have been satisfactory. We propose to construct here a circular well down to about grade 10, and approximately 30 feet in diameter, with a pumping station and its appurtenances, which together will constitute virtually a duplicate of our present pumping plant. These works are to be located in the basin of the pond, which is to be pumped out, cleaned out and filled with good material. As now designed the well is to be near the center of the pond, about 100 feet easterly from test well No. 37, as shown on blue print on file with you, dated Jan. 9, 1907. Test well No. 40 is within the area of the proposed large well.
>
> It is also our purpose to obtain, if practicable, about an acre of additional land to use with the leased land. Material which can be used for filling purposes may thus be had.
>
> We have available for use on this site appropriations amounting to $68,000. This amount is estimated to cover the whole cost, and is much less than the cost of a supply of water adequate for our use from other available sources.
>
> We propose also to construct a branch of the Roberts sewer to this district, to sewer all the buildings in the vicinity this year.
>
> We respectfully desire speedy action on the communication that we may proceed rapidly with the construction work in order to get it completed this year.

The application is accompanied by a plan showing the location of the proposed new well and pumping station, and by information as to the character of the soil in the locality south of the Cambridge pipe line, as shown by the material encountered in sinking five new test wells in the region indicated, two of which are located in the small pond referred to and the remaining three in the gravelly land south of the pond. Samples of water sent in by you from four of these test wells have been analyzed.

The Board has caused the locality to be examined by its engineer and has considered the plans and information presented.

The location of the proposed new well, in the middle of a small pond on the southerly side of the Cambridge pipe line, east of South Street, is about 180 feet south of the group of tubular wells from which the pumping test was made in the latter part of the year 1904. So far as the new test wells show, the character of the soil south of the Cambridge pipe line is very similar to that on its northerly side, being composed of gravel and sand of varying degrees of fineness to a depth of about 30 feet, beneath which there is a stratum of coarse sand and gravel from which water can be drawn very freely.

The quality of the water from these test wells also, as shown by single analyses of samples taken from four of the wells, is about the same as that obtained from the test wells north of the Cambridge pipe line in 1904, which was of good quality for the purposes of a public water supply.

The results of the tests thus far made are, in the opinion of the Board, favorable to obtaining by the plan now proposed a large supply of ground water of good quality for the use of the city. If necessary, the supply can probably be increased by the addition of a system or systems of tubular wells located at suitable places in the region about the large well.

It is understood that the two dwelling houses nearest the proposed well are to be controlled by the city, and that the extension of the main sewer to take the sewage of dwelling houses in this region, including the houses about Roberts station, is to be carried out in connection with the construction of the proposed new works.

WALTHAM (AMERICAN WATCH TOOL COMPANY).

MAY 2, 1907.

To MR. S. A. BARTON, *Treasurer and Manager of the American Watch Tool Company, Waltham.*

DEAR SIR: — In accordance with your request of April 4, 1907, the State Board of Health has caused the well on your premises, from which you desire to supply water for drinking, to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water is turbid and colored, has an unpleasant odor, and contains much more organic matter than is found in a good well water. It also contains an excessive amount of iron and is very hard, its hardness and organic matter having greatly increased since 1889, and the Board does not advise its use for drinking.

WALTHAM (JUDSON L. THOMSON MANUFACTURING COMPANY).

OCT. 3, 1907.

To the Judson L. Thomson Manufacturing Company, Waltham, Mass.

GENTLEMEN: — In response to your request of Sept. 16, 1907, for a further examination of the water of a well on your premises in Waltham, the Board has caused the locality to be examined by one of its engineers and a sample of the water to be analyzed.

The results of this analysis show no improvement in respect to the hardness of the water and very little in the quantity of organic matter present, as compared with former examinations, and, in the opinion of the Board, the water of this source cannot be considered safe for drinking.

WARE (PINE GROVE MINERAL SPRING).

DEC. 5, 1907.

To Mr. HENRY C. DAVIS, *Ware, Mass.*

DEAR SIR: — In response to your request of Nov. 15, 1907, for an examination of the Pine Grove Mineral Spring, so called, and advice as to its quality, the Board has caused the locality to be examined by one of its engineers and a sample of the water to be analyzed.

The region about the spring is uninhabited, and the analysis indicates that the water is naturally of good quality. It contained at this time, however, a somewhat larger quantity of organic matter than is found in good spring waters, and a considerable number of bacteria, conditions which were probably due to the work of walling up the spring and constructing the building over it which had just been completed.

It is probable, in the opinion of the Board, that after a considerable quantity of water has been drawn or allowed to run to waste from the spring the water will be of good quality for drinking.

WAREHAM (WAREHAM FIRE DISTRICT).

JULY 9, 1907.

To Messrs. JOHN C. MAKEPEACE, EDWARD A. GAMMONS and WILLIAM A. LEONARD,
Water Commissioners of the Wareham Fire District.

GENTLEMEN: — The State Board of Health received from you on June 29, 1907, an application for advice as to a proposed water supply for the Wareham Fire District, to be taken from tubular wells to be located in the valley of Mosquito Brook, a short distance northwest of the village of Tihonet, and has caused the locality to be examined by its engineer.

Test wells sunk in this locality penetrated a stratum of porous soil from which water could be pumped very freely, and the results of a pumping test made by pumping from a group of six of these wells, connected with a steam pump, for a period of a little over three days, beginning on June 21, indicate that a sufficient supply of water for the Wareham Fire District can be obtained from the ground at this place by means of suitable works.

The results of analyses of samples of water collected at intervals during this test show that the ground water in this locality is of excellent quality for the purposes of a public water supply.

The Board hereby approves the use of water from the ground at this place for the supply of the Wareham Fire District.

The Board would recommend that, in the construction of permanent works, the wells be located somewhat farther from the meadow than some of the wells used in the recent test and that they be extended to cover as large an area as practicable: also that enough land be acquired in the neighborhood of the wells to protect the water from danger of pollution.

WAYLAND.

SEPT. 5, 1907.

To the Board of Water Commissioners, Wayland, Mass., MR. CLARENCE S. WILLIAMS, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on July 29, 1907, an application for advice as to improving the water supply of the town of Wayland, accompanied by a report of your engineer with plans describing the proposed works.

The plans provide for filtering the water from the upper basin of the Snake Brook Reservoir, before admitting it to the lower basin, through a covered sand filter to be constructed in the dike between the basins, and for diverting the remaining water from the upper basin through a conduit discharging below the dam of the lower basin. It is also proposed to improve a swamp near the upper end of the lower basin.

While presenting this plan of improvement and an estimate of the probable cost thereof, indicating that the total expense is likely to exceed $4,300, your engineer, after a study of the question, concludes that extensive and costly alterations must be made in the present water works of the town in order to improve materially the quality of the water and make the service satisfactory, and does not recommend the adoption of the presented plan, but recommends that for the present a supply of water be obtained temporarily from the town of Natick, and that arrangements be made for a permanent supply in future either from that source or some source from which a supply of good ground water can be obtained.

The Board has carefully considered the application and the information presented therewith and has caused the locality to be examined by its engineer.

Both the basins of the reservoir on Snake Brook are for the most part very shallow, and it is probable that if the water of the upper basin should be diverted entirely from the lower basin the water of the latter would still have a high color and be objectionable at times on account of a disagreeable taste or odor; and even if enough filter capacity should be provided to filter all of the water available from the upper basin, in the portion of the year when the use of water from that basin is necessary, the improvement effected would not be a very material one if the filtered water were afterward mingled with the water of the lower basin. The cost of providing the necessary works would, moreover, be large, and there would be in addition a very considerable annual cost for the maintenance of the filter.

There appears to the Board only two practicable ways of improving materially the quality of the water of the Snake Brook source: one by thoroughly cleaning both the reservoirs and draining the swamps on the watershed, and the other by filtering all of the water supplied to the town. The former plan would be impracticable unless a supply should be obtained from some other source while the work is in progress, and would not probably result in giving the town an unobjectionable water at all times, while to filter the whole supply from this reservoir would materially reduce the available head, already too small for the present requirements, so that in connection with the latter plan it would doubtless be necessary to pump all of the water. Considering the large cost of any plan for improving the water of this source, and the probability that the yield will soon be found insufficient for the requirements of the town, it is not desirable, in the opinion of the Board, for the town to incur any further expense in the improvement of this source if a better one can be secured.

The investigations of your engineer show that it would be practicable for the town to obtain a water supply from the works of the town of Natick by the construction of a comparatively short pipe line, through which a much more efficient service would be furnished than is obtainable from the present source. The water supplied from the Natick works is of excellent quality, and the quantity available is ample for the present requirements, at least, of both Natick and Wayland. In the opinion of the Board, the plan suggested, provided a satisfactory arrangement can be made with the town of Natick, would be an appropriate one for securing a satisfactory water supply for the town of Wayland.

It is also very probable that Wayland can obtain an adequate supply of good water from the ground in the neighborhood of Lake Cochituate or elsewhere in the town, if it is deemed preferable to take water from an independent source. If you should decide to make tests with a view to obtaining an independent supply of water, the Board will assist you in so far as it can in the necessary investigations, and will give you further advice when the results of further investigations are available.

WESTFORD.

AUG. 1, 1907.

To the Westford Water Company, Westford, Mass., MR. EDMUND M. BLAKE, *President.*

GENTLEMEN: — The State Board of Health received from you on July 25, 1907, an application for the consent of the Board, under the provisions of chapter 175 of the Acts of the year 1907, to the taking of water for the supply of the town of Westford from a system of tubular wells located about 250 feet north of the highway known as Pine Street, leading from Forge Village to Westford Center, and 450 feet west of the Nashua & Acton Branch of the Boston & Maine Railroad, and has caused the locality to be examined by its engineer.

The wells are located near the edge of a meadow south of Stony Brook, the nearest well being about 25 feet and the farthest one 75 feet from the edge of the meadow.

The results of a pumping test made by pumping from these wells for a period of about three days, at a rate of about 150,000 gallons in twenty-four hours, have been submitted by you, and samples of water collected and sent in during the test have been analyzed.

The results of the analyses show that the water is of excellent quality for all the purposes of a public water supply.

The wells are located in an uninhabited region where the soil appears to be very favorable for the absorption of water from the rainfall, and, taken in connection with the results of the pumping test, indicate that an ample supply of water for the requirements of Westford can be obtained from the ground at this place.

Some of the wells used during the pumping test are located nearer the edge of the swamp than is desirable, and the board would recommend that in putting in the final works all of the wells be located at least 50 feet from the swamp.

The Board hereby consents to the taking of water from this source for the supply of the town of Westford, under the provisions of chapter 175 of the Acts of the year 1907, and to the taking of the lands indicated on the plan submitted for preserving the quality of the water. The lands, the taking of which is herein approved, are shown on a plan on file in this office entitled "Westford Water Company. 1907. Plan of Lot for Wells and Pumping Station. Scale 40 Ft. per Inch. Edmund M. Blake, Engineer," and are bounded, measured and described as follows: —

Beginning at the southwesterly corner of the said lands at a stone bound at the northerly side of the Forge Village road, or Pine Street, at the boundary of lands now or formerly of Nelson L. Prescott; thence N 14 ° 45 ′ E eight hundred and sixty-four (864) feet to Stony Brook, so called; thence easterly along said brook to land now or formerly of the Nashua and Acton Railroad; thence southerly by said last named land eight hundred and seventy (870) feet to land now or formerly of one Sarah Conant; thence westerly by land of said Conant six hundred and fifty-six (656) feet to said road; thence northwesterly by said road two hundred (200) feet to the point of beginning. The total area of land included in the above described parcel is about fourteen (14) acres.

West Newbury (Thomas S. Lunt).

June 6, 1907.

To Mr. Thomas S. Lunt, *Newburyport, Mass.*

Dear Sir: — In response to your request of May 27, 1907, for an examination of the water of a certain spring on the southwesterly side of Turkey Hill in West Newbury, and advice as to its quality, the Board has caused the spring to be examined and a sample of the water to be analyzed.

The watershed of the spring is uninhabited, and the water, though hard, is of good quality and safe for drinking at the present time.

Weston (Well at Kendal Green).

Sept. 13, 1907.

To the Board of Health, Weston, Mass., Mr. E. O. Clark, *Secretary.*

Gentlemen: — The State Board of Health received from you on Aug. 23, 1907, an application for advice as to the quality of the water of a well used to supply a school building on North Avenue, not far from Viles Street, in the section of Weston known as Kendal Green, and has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water has an offensive odor and contains an excessive quantity of organic matter and iron, and in the opinion of the Board the well is an unfit source from which to take water for drinking.

The Board would recommend that the further use of this well be prevented.

WESTON (WELL AT SCHOOLHOUSE).

NOV. 7, 1907.

To the Board of Health of the Town of Weston, MR. E. O. CLARK, *Secretary.*

GENTLEMEN: — In accordance with your request of Oct. 7, 1907, the State Board of Health has caused an examination to be made of the water of a well used to supply a school building at the corner of South Avenue and Ware Street in Weston, and a sample of the water therefrom to be analyzed.

The results of the analysis show that the water had at that time a disagreeable odor and contained a much greater quantity of organic matter than is found in good well waters. The water of this well in its present condition is not suitable for drinking, and the Board would recommend that its use be discontinued.

WEST SPRINGFIELD.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Sept. 5, 1907, for preventing the pollution and securing the sanitary protection of the waters of Darby Brook Reservoir and Bear Hole Brook and their tributaries, used by the town of West Springfield as sources of water supply.

WOBURN.

AUG. 22, 1907.

To Hon. WILLIAM E. BLODGETT, *Mayor, Woburn, Mass.*

DEAR SIR: — The State Board of Health is informed that water from Horn Pond is being drawn into the pipes and supplied to the city of Woburn for drinking.

In the opinion of the Board, it is not safe to drink this water unless it has previously been boiled for at least fifteen minutes.

Every precaution should be taken to prevent unnecessary use or waste of water in the city, in order that the draft from Horn Pond may be shut off as soon as possible, and the inhabitants should be advised to continue boiling all water used for drinking from the city mains until one week after the use of water from Horn Pond has been discontinued.

WRENTHAM.

AUG. 1, 1907.

To the Board of Water Commissioners of the Town of Wrentham.

GENTLEMEN: — The State Board of Health received from you, through your engineer, on July 29, 1907, an application requesting its approval, under the provisions of chapter 86 of the Acts of the year 1904, as extended by chapter 291 of the Acts of the year 1907, of the taking of a supply of water for the town from a system of tubular wells located at the upper end of the Trout Ponds, so called, and has caused the locality to be examined by its engineer and samples of the water to be analyzed.

The results of the analyses show that water flowing from wells in this locality is of excellent quality for the purposes of a public water supply.

The evidence furnished by measurements of the flow of water from a test well driven in this locality in 1904, and by measurements of the yield of other test wells, both while flowing naturally and while pumping with a hand pump, taken in connection with the character of the soil in the region, indicates that a sufficient supply of water for all the necessary requirements of the town of Wrentham can probably be obtained from the ground at this place, and it is practicable, in case a further supply is found necessary, to secure an additional quantity of water lower down the valley.

The Board approves the taking of water from the ground near the Trout Ponds for the water supply of the town of Wrentham, and approves also the taking of lands within the watershed of the Trout Ponds, between the highway north of the ponds and the outlet of the larger pond, as shown on the plan filed in this office, entitled "Wrentham Water Works. 1907. Plan of Land taken for Source of Supply at the Trout Ponds. Scale — 1″ = 100′. Edmund M. Blake, Engineer," the total area included being about 42½ acres, which is bounded, measured and described as follows: —

Beginning at the most northwesterly corner thereof at a point about one hundred (100) feet northwesterly of the northwesterly side of the "Lower Trout Pond," so called; thence running south thirty-four degrees fifteen minutes (34 ° 15 ′) west three hundred and ninety-three and seven-tenths (393.7) feet; thence south twenty-nine degrees thirty minutes (29 ° 30 ′) east fifty and two-tenths (50.2) feet; thence due west one hundred and thirty-three (133) feet; thence south twenty-five degrees (25 °) east three hundred and nine and five-tenths (309.5) feet; thence south sixty-eight degrees (68 °) east five hundred and seventy-seven (577) feet; thence north eighty-four degrees forty-nine minutes (84 ° 49 ′) east ninety-three (93) feet; thence south fourteen degrees (14 °) west forty-two and nine-tenths (42.9) feet; thence south seventy degrees forty-five minutes (70 ° 45 ′) east thirteen hundred and seventy (1,370) feet, to Taunton Street; thence north thirteen degrees forty-five minutes (13 ° 45 ′) east on Taunton Street eleven hundred and seventy-three and nine-tenths (1,173.9) feet; thence north eighty-five degrees forty minutes (85 ° 40 ′) west thirteen hundred and eighty-eight and four-tenths (1,388.4) feet; thence south thirteen degrees thirty minutes (13 ° 30 ′) west one hundred and eighty-one and four-tenths (181.4) feet; thence north sixty-eight degrees thirty minutes (68 ° 30 ′) west five hundred and thirty-nine and eight-tenths (539.8) feet, to the point of beginning.

Wrentham (State School).

April 4, 1907.

To George L. Wallace, M.D., *Superintendent of the New School for the Feeble-minded at Wrentham.*

Dear Sir: — In response to your request for an examination of certain wells in lands recently acquired as a location for a new school for the feeble-minded at Wrentham, the Board has caused the wells indicated, known respectively as the Hurley well and the Farrar well, to be examined and samples of their waters to be analyzed.

The results of the analyses show that the waters of both wells contain a larger quantity of organic matter than is found in good well waters, and the numbers of bacteria in both cases were large, and in their present state these waters are unsafe for drinking. If the wells should be cleaned out thoroughly, the upper portions of their walls laid in mortar and tight covers provided, so as to prevent the entrance of surface water, and all cesspools or vaults removed from their neighborhood, it is possible that the water of these wells might safely be used for drinking.

The water of the well at the Farrar place contains an excessive quantity of iron, apparently derived from the pipe through which it is discharged from the pump, and it is desirable that the use of iron pipe for conveying this water should be discontinued. It is also very important to avoid the use of lead pipes in connection with well waters such as these.

If you decide to attempt to improve these wells for the supply of the institution the Board will, if you so request, make a further examination of their waters after the improvements suggested have been made.

July 9, 1907.

To George L. Wallace, M.D., *Superintendent, Wrentham State School, Wrentham, Mass.*

Dear Sir: — In response to your request the State Board of Health has caused a further examination to be made of the waters of certain wells and springs upon the lands of the State School at Wrentham and samples of their waters to be analyzed.

The water of the well at the Hurley place shows a marked improvement in most respects over its condition at the time of the previous examination, and it is probable that the water of this well can with safety be used for drinking.

The water of the spring at the Farrar place is of excellent quality for drinking purposes. If this source is to be used, however, the spring should be covered, so as to exclude surface water and prevent danger of pollution.

The water of the well at the Snow place contains a greater quantity of organic matter than is found in good well waters, which may possibly be due to the use of fertilizer upon lands above the well and possibly also to sewage from a house on the opposite side of the highway. It is probable that, by removing the sewage from this house to a greater distance and discontinuing the use of fertilizer on the lands above the well, the water can safely be used for drinking.

Nov. 7, 1907.

To GEORGE L. WALLACE, M.D., *Superintendent, Wrentham State School, Wrentham, Mass.*

DEAR SIR: — In accordance with your request the State Board of Health has caused a further examination to be made of the water of the well located at the Farrar place and a sample of its water to be analyzed.

The results of the analysis show a very considerable improvement in the quality of the water, as compared with previous analyses, but the water still contains a larger quantity of organic matter and a greater number of bacteria than are found in good well waters, and the Board cannot recommend its use for drinking.

ICE SUPPLIES.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sources of ice supply: —

CHICOPEE.

MARCH 7, 1907.

To the Board of Health of the City of Chicopee.

GENTLEMEN: — In response to your request of Feb. 11, 1907, for advice as to the quality of the ice cut from Bemis Pond, Bleachery Pond and the Ellis Chapin Pond, so called, situated at Chicopee, the Board has caused the ponds and their surroundings to be examined and samples of the water and ice of each to be analyzed.

The results of the analyses show that the clear ice beneath the snow ice is in each case of good quality, and, in the opinion of the Board, the ice from these sources may safely be used for domestic purposes if the snow ice and the first inch of clear ice that formed upon the pond shall be removed, and ice containing particles of foreign matter rejected.

There is a group of buildings near the upper end of Chapin Pond, pollution from which might under some circumstances find its way into the pond. Though this does not appear to be the case at the present time, continued care should be taken in future to prevent danger of pollution from these buildings.

MAY 2, 1907.

To the Board of Health of the City of Chicopee.

GENTLEMEN: — In response to your request for advice as to the use of certain ponds in Chicopee as sources of ice supply, the Board has caused the sources to be examined and samples of water and ice from two of them to be analyzed.

The watersheds of Bemis Pond and of Poor Brook Pond contain a small population, but there appears to be no direct pollution of either source by sewage. Ice from these sources can, in the opinion of the Board, be used with safety for domestic purposes, provided that all snow ice and the first inch of clear ice that formed on the ponds be removed before using, and that all ice containing particles of foreign matter be rejected.

Two other small sources — viz., Dingle Pond, located near Montgomery Street, and Springwater Pond, not far from the Granby road — were also examined. Each of these ponds is quite small and is evidently fed by unpolluted ground water, and, in the opinion of the Board, both are safe sources of ice supply. In the case of these sources also it is advisable to remove all snow ice and the upper inch of clear ice before using, and to reject all ice containing particles of foreign matter.

CONCORD.

MARCH 7, 1907.

To Mr. JOHN M. KEYES, *Chairman of Board of Selectmen, Concord, Mass.*

DEAR SIR: — In response to your request of Feb. 15, 1907, the Board has caused the ice pond near the Cambridge turnpike, referred to in your communication, to be examined by one of its engineers and a sample of the ice to be analyzed.

The results of this examination show that the pond was not being injuriously polluted at this time, and that the ice, though containing a somewhat larger quantity of organic matter than is ordinarily found in good ice, was safe for domestic use. The Board would recommend, however, that the snow ice and the first inch of clear ice be removed before using, and that all ice containing particles of foreign matter be rejected.

GROTON (H. J. BUSHWAY).

APRIL 4, 1907.

To Mr. H. J. BUSHWAY, *The Bushway Ice Cream Company, 91 Hampshire Street, Cambridge, Mass.*

DEAR SIR: — In response to your request of March 2, 1907, for an examination of the ice of Massapoag Pond, situated at East Groton, and advice as to whether ice from this source may safely be used for domestic purposes, the Board has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

The results of the examination show that the drainage area of the pond is sparsely populated, and that, excepting summer camps along the shores of the pond, there are very few inhabitants in its neighborhood.

The results of the analysis of a sample of the ice show that at this time the snow ice contained a large quantity of organic matter and a considerable number of bacteria, but that the clear ice beneath the snow ice was of good quality. In the opinion of the Board ice which may safely be used for domestic purposes can be obtained from this pond if all of the snow ice and the first inch of clear ice that formed upon the pond shall be removed before the ice is supplied for use, and if all ice containing particles of foreign matter shall be rejected.

WHITMAN (F. F. DOWNES).

MARCH 9, 1907.

To Mr. F. F. DOWNES, *26 Myrtle Street, Jamaica Plain, Mass.*

DEAR SIR:—In response to your request of Feb. 24, 1907, for an examination of Brigham Pond in Whitman, and advice as to the use of ice from that source for domestic purposes, the Board has caused the pond to be examined and a sample of ice taken from the lower end of the pond to be analyzed.

The results of the analysis show that the snow ice is of poor quality, and that the clear ice beneath the snow ice contains a larger quantity of organic matter than is found in good ice, though the number of bacteria was low.

The chief possible sources of pollution of the pond are located near its extreme lower end, where the sample was collected, and it is probable, in the opinion of the Board, that ice which will be safe for domestic purposes can be obtained from the middle and upper portions of this pond, provided that the snow ice, including the first inch of clear ice that forms upon the pond, be rejected, and only the clear ice beneath the first inch retained for use. It is also important that all ice containing particles of foreign matter be rejected, and that no ice be cut within 100 feet of the shore in the southerly part of the pond bordering South Avenue.

The nearness of the lower end of this pond to a dense and apparently increasing population makes it evident that, even with the restrictions indicated, its use as a source of ice supply for domestic purposes cannot be longer continued with safety, and ice cutting on this stream should be restricted in future to the neighborhood of, or above, Plymouth Street.

WHITMAN (WHITMAN & ABINGTON ICE COMPANY).

MAY 2, 1907.

To the Whitman & Abington Ice Company, Whitman, Mass.

GENTLEMEN:—In response to your request for advice as to the use of Hobart's Pond in Whitman as a source of ice supply, the Board has caused the pond and its surroundings to be examined and samples of the water to be analyzed.

There is a large population within the watershed of the pond, but there are no serious sources of pollution in its immediate neighborhood at the present time. It is probable, in the opinion of the Board, that ice which may safely be used for domestic purposes can be obtained from this pond for several years in the future, provided that all snow ice and the first inch of clear ice that formed upon the pond be removed before it is used, and that all ice containing foreign substances be rejected.

WINCHESTER.

MAY 2, 1907.

To the Board of Health of the Town of Winchester, LILLEY EATON, M.D., *Chairman.*

GENTLEMEN: — In response to your request for advice as to the use of Wedge Pond as a source of ice supply the Board has made a further examination of the source and has caused a sample of the ice taken therefrom to be analyzed.

The question of the use of this pond as a source of ice supply was submitted to this Board for its advice in the year 1900, and the Board advised at that time as follows: —

> Wedge Pond is fed chiefly by Horn Pond Brook, the water of which enters the pond near one end and flows out close to the place at which it enters. Horn Pond Brook receives the drainage from a densely populated area, from which considerable pollution enters the brook. While these conditions would render the pond an unsafe source of drinking water, the circumstances are such that it is possible to obtain ice from this pond that can be used with safety by removing from the ice, after cutting, the first inch that formed upon the pond and all of that which formed above this first inch, from snow or rain or flooding, and retaining for use only the clear ice which forms under the first inch. If the ice of Wedge Pond is treated in this way, the ice thus retained can, in the opinion of the Board, be safely used for domestic purposes.

The results of the analysis of the sample of ice collected recently show that it contains more organic matter than samples collected several years ago. While it is probable that by observing the precautions suggested in the communication quoted above, and by rejecting all ice containing particles of foreign matter, the ice taken from this pond during the past winter could safely be used for domestic purposes, the source cannot be regarded as a safe one under the existing conditions, and its further use should be discontinued.

SEWERAGE AND SEWAGE DISPOSAL.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sewerage and sewage disposal: —

ASHFIELD.

SEPT. 5, 1907.

To the Board of Selectmen of the Town of Ashfield.

GENTLEMEN: — The attention of the Board has been called to the condition of Plain Brook, flowing from Great Pond through the village of Ashfield to South River, and the Board has caused the stream to be examined by one of its engineers.

The results of the examination show that the stream now receives either sewage or sink drainage from thirty to forty houses, a hotel and a sewer with which a considerable number of houses is connected. These conditions are extremely objectionable from a sanitary point of view, and the Board would recommend that immediate measures be taken to remove the sewage from the brook and provide for its proper disposal.

It appears to be practicable to construct a sewer in the valley of the brook which will intercept all of the sewage which is now discharged into it and convey it to some point below the village, where it can be disposed of upon land without objection; and, in the opinion of the Board, that would be the best practicable plan of removing the objectionable conditions which now exist there.

When plans for the collection and disposal of the sewage have been prepared the Board will advise you concerning them, if you so request.

DEC. 17, 1907.

To the Board of Selectmen of the Town of Ashfield, MR. F. H. SMITH, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Nov. 1, 1907, an application for advice with reference to a proposed sewer in the town of Ashfield, accompanied by a plan showing the location of the proposed sewer and outlet.

The plan submitted provides for laying a sewer from the easterly side of the Shelburne road through the valley of Plain Brook to a point about 725 feet east of Main Street, where it is proposed to discharge the sewage directly into the stream. The total length of this sewer is 1,940 feet, about 900 feet at the upper end being 12 inches in diameter and the remainder 15 inches in diameter. The plan shows that the upper part of the sewer for a length of 900 feet is to be laid in the channel of the brook.

The Board has caused the locality to be examined by its engineer and has considered the plan presented.

There are several objectionable features in this plan. If the sewer should be laid in the channel of the brook it would be difficult to make connections with it or repair it, and it is impracticable to lay a sewer in such a location in such a manner as to prevent the leakage of considerable quantities of water into the sewer through the joints. It is very desirable to exclude surface water from this sewer, and if that shall be done the sewer can be built of considerably smaller sizes than proposed in the plan presented. The proposed plan of disposing of the sewage by discharging it directly into the brook is a very objectionable one, and would result in a serious nuisance and possible injury to those living on the stream below.

The best plan of disposing of the sewage will be to discharge it upon beds of sand or gravel, and there appears to be coarse sand or gravel suitable for the purpose in the neighborhood of the brook near the proposed sewer outlets. For present requirements an area of filter beds amounting to about half an acre will be sufficient for the purification of the sewage. The necessity for purifying the sewage in this case is an added reason for keeping surface water out of the sewers, and the Board would recommend that the catch-basins now connected with the old sewer be disconnected and provided with some other outlet, or that a new sewer be constructed to receive the sewage from the buildings tributary to the present sewer. Water collected in catch-basins from street surfaces may be discharged directly into the brook without objection.

The Board will, upon request, give you further advice in this matter when plans comprising the changes suggested have been submitted.

Brockton.

May 13, 1907.

To the Board of Sewerage Commissioners of the City of Brockton, Mr. Charles R. Felton, *Clerk.*

Gentlemen: — The State Board of Health received from you on April 16 an application for the approval by the Board, under the provisions of chapter 49, section 1, of the Revised Laws, of the purchase or taking of certain lands in the city of Brockton, accompanied by a plan and a description of the lands which it is proposed to take, which are situated in the city of Brockton adjacent to the present filter beds of that city and bordering the boundary line between Brockton and West Bridgewater.

In response to this application the Board gave a public hearing, as required by law, at its office, Room 141, State House, on Thursday, May 2, 1907, at 11 a.m., due notice of said hearing having been given by publication in newspapers in the city of Brockton.

After the hearing the Board voted to approve the purchase or taking of the lands indicated upon the plan submitted for the purification and disposal of sewage, said lands being bounded, measured and described as follows: —

Beginning at a point in the boundary line between the City of Brockton and the Town of West Bridgewater, said point being 357.55 feet easterly from the east line of Pearl Street; thence easterly by said boundary line between Brockton and West Bridgewater, a distance of about 1,448 feet to the westerly line of Liberty Street; thence northerly by the westerly line of Liberty Street about 1,200 feet to a stone bound marking the northerly line of land taken by the City of Brockton for a sewerage force main; thence westerly by the northerly line of said taking over land owned by Milo Manley and Albert Manley a distance of about 1,250 feet to a fence line marking a former division between land of Milo Manley and Charles G. Manley; thence S. 62 ° 58 ′ W. in range of said fence line about 15 feet to the easterly line of land approved by the State Board of Health on April 17th, 1893, for the disposal of sewage by the City of Brockton; thence S. 0 ° 31 ′ W. 335.68 feet, S. 16 ° 45 ′ W. 256.99 feet, S. 56 ° 54 ′ W. 229.99 feet, and S. 11 ° 42 ′ W. 415.6 feet to the point of beginning.

The area of the above described parcel of land is 36 acres, and is owned by the City of Brockton, Milo Manley and Albert Manley.

Canton (Neponset Woolen Mills).

Sept. 5, 1907.

To the Neponset Woolen Mills, Canton, Mass.

Gentlemen: — The State Board of Health received from you on July 27, 1907, through your engineer, an application for advice as to the disposal of the manufacturing wastes produced at the factory, accompanied by a plan of the proposed works, which are described as follows: —

It is proposed to collect all of the objectionable wastes in a pump well to be located in one of the abandoned tailraces, and to raise them by means of a centrifugal pump to two settling tanks, each of which is to have a capacity of 10,000 gallons. From these tanks the effluent will go to filters to be constructed of cinders produced in the boiler house.

The filtration area is to consist of four filter beds, having a combined area of .4 of an acre, the depth of filtering material to be 3.5 feet. The average rate of filtration through these beds will be about 60,000 gallons per acre per day.

No provision has been made for intermittent dosing of the beds, but the sewage will flow continuously during the hours that the mill is in operation. It is thought that the rate of flow will be so large, as compared with the size of the beds, that fairly satisfactory dosing can be accomplished without the use of a flush tank.

The sludge which accumulates at the bottom of the settling tanks will be discharged on sludge beds which are to be constructed in the abandoned tailraces. These sludge beds will consist of 3 feet of cinders above the level of the water in the tailraces. Two sludge beds are to be constructed in the beginning, each of which will have an area of about 1,200 square feet. When the entire contents of one of the tanks is discharged on a bed, it will flood it to a depth of 12 inches.

The Board has examined the plans presented and has considered the results of experiments upon the purification of these wastes.

The total quantity of waste originally discharged from the mill has recently been greatly reduced by excluding leakage from the canal, and examinations of the amount of foul waste now discharged indicate that it could, without special difficulty, be reduced to 25,000 or 30,000 gallons per day as the mill is now operated.

Experiments upon the treatment of this waste show that it can be efficiently purified after sedimentation, by filtration through sand at rates of 50,000 gallons per acre per day. Whether it can be sufficiently well purified by filtration through cinders, as now proposed, at a somewhat higher rate, cannot be definitely stated, but it is probable that the resulting effluent from such treatment would be sufficiently purified to admit of its discharge into the adjacent stream. It will be desirable, however, to increase the area of filters somewhat so that the rate of filtration will not exceed 50,000 gallons per acre per day. It is also important that the use of cinders containing either large clinkers or much fine ash be avoided.

The proposed settling tanks are of adequate size and well adapted for the purpose for which they are to be used, and the proposed method of disposing of the sludge appears to be the best that it is practicable to adopt.

Works constructed in accordance with the plan proposed, with the enlargement of the area of filter beds suggested, will, in the opinion of the Board, provide satisfactorily for the purification of the wastes from this mill if the works receive the necessary attention, so long as the quantity of waste remains no greater than is indicated in the application.

CHELSEA.

JULY 9, 1907.

To the Hon. EDWARD E. WILLARD, *Mayor, Chelsea, Mass.*

DEAR SIR: — The attention of the Board has been called to a nuisance existing near the foot of Shurtleff Street in the city of Chelsea, due to the discharge of sewage from one of the public sewers of the city. The dry-weather flow of this sewer, the Board is informed, was discharged formerly into sewers leading to the metropolitan sewer which passes through Marginal Street, but the connection with that sewer has been closed.

The Board has on previous occasions called attention to the serious pollution of the upper portion of Boston harbor by sewage, due largely to the unnecessary discharge of crude sewage from the sewers of the city of Chelsea. Unless the further discharge of sewage upon the shores and into the waters about the city of Chelsea shall be prevented before the end of the current year and the sewage discharged into the metropolitan system, which was designed to receive it, it will become the duty of this Board to report the matter to the Legislature for such action as may be necessary to prevent the present objectionable conditions.

DEDHAM (COCHRANE MANUFACTURING COMPANY).

SEPT. 5, 1907.

To the Cochrane Manufacturing Company, East Dedham, Mass.

GENTLEMEN: — The State Board of Health received from you on July 18, 1907, through your engineer, Mr. E. Worthington of Dedham, plans of a proposed system of disposal for the manufacturing wastes from your mill at East Dedham, accompanied by a report describing the proposed wastes and the proposed plan for the purification thereof. From this report it appears that the total quantity of manufacturing waste now being discharged from these works amounts to about 31,000 gallons per day, of which about 2,000 gallons result from the washing of wool.

The plan of disposal is outlined as follows: —

> The plan is largely sedimentation and filtration. The carpet mill wastes from the wool-scouring machines and from the yarn dyeing and washing tubs enters a concrete tank in the dye house about 7 feet square and 4.3 feet deep. The overflow from this tank is by means of 10-inch pipe, which crosses the tailrace and *enters the basement of the old dye house, which is to be concreted and made a settling basin.* Into this basement will drop the remaining drainage from all machines on this side of the stream, as has been enumerated. *This basin will be about 90 feet long and 40 feet wide, and will contain about 3½ feet before overflowing.* It discharges into a brick tank or basin outside 8 by 14 feet and 6 feet deep. From this basin will lead the 10-inch pipe across the stream to the north side, and by a 10-inch sewer pipe, as shown upon the accompanying plan, this waste will be conducted to a point below the mills on the north side and there discharged on to the filter bed. On the north side a tight drain is laid through the mills and all discharges conducted into it, these discharges going direct through to the filter beds discharging at the same point as the wastes from the south side. The filter bed is composed of cinders 3 feet thick and the discharge of the wastes will be on to this bed. The area of this bed is 13,600 square feet.

Operation of the System.

The discharges will be by gravity. The various tanks and settling basins will have to be pumped out and cleaned by hand as often as may be necessary. The top of the filter bed can be raked and scraped from time to time, as may be required.

The Board has examined the proposed plan and the results of analyses of the wastes from this mill and of experiments upon the purification thereof.

The results of the investigations indicate that the wastes can be purified efficiently by sedimentation and filtration through filter beds of sand or cinders, the sand filters giving the better results.

The capacity of the proposed settling tanks is in the aggregate sufficient for the purpose; but under the present plan part of the wastes will not be passed through the tanks but be delivered directly to the filter bed. It is important that all of the waste be passed through a settling tank. The tank will require frequent cleaning, and should be built with two or more compartments, so that one may be in use while the other is being cleaned. It will be found of advantage also to provide for emptying the contents of this tank upon sludge beds prepared for the purpose, so that the sludge may be dried before final disposal. Under the circumstances it would be better to locate the tank at or near the filter bed rather than in the place now proposed, and to provide sludge beds there on which the contents of the settling tanks can be discharged for drying. The dried sludge could then be removed and disposed of without difficulty.

The proposed small settling tank to receive the wastes of the wool-scouring machine is a desirable provision, in order to remove from those wastes the heavier matters and grease which might tend to clog the main pipe.

The filter bed shown upon the plan has an area of 13,600 square feet, and is to be constructed to a depth apparently of 2½ to 3 feet. With a filter composed of cinders of the size proposed it might be possible to effect a sufficient purification of the wastes from this mill if the quantity amounts to no more than 31,000 gallons per day, but there is likely to be difficulty in securing satisfactory results with so small an area.

The bed shown upon the plan has a slope of 1 in 400 from the point where the waste enters to the opposite side of the bed, the total fall being a little less than half a foot. With such a slope the wastes would, after a short period of use, tend to collect in a pool near the lower end of the bed, causing uneven distribution and probably unsatisfactory results in the operation of the filter.

The Board would recommend that the area of filter be increased to as much as twice the area of the bed indicated upon the plan, that the surface be made level or with a slope no greater than 1 in 800, and that the area be divided into two or more beds, so that one can be cleaned while the other is in use. Means should also be provided for delivering the waste from the factory upon each bed separately or upon all of them at the same time, as may be desired.

The filter beds are so near the level of Mother Brook that it would be difficult to operate them satisfactorily at times of high water in the brook. While it is evident that very little head is available for conveying the wastes to the filter beds, it is important that the filters be placed at as high a level as possible with reference to the water in the brook, and it appears to be practicable to place them at a somewhat higher elevation than shown on the plan.

With the suggested changes in settling tanks and filter bed, the Board is of the opinion that the wastes from this mill, while the quantity is no greater than indicated by the measurements furnished by your engineer, can be purified to such an extent that it will be permissible to discharge the effluent from the underdrains of the filter beds directly into Mother Brook.

DOVER (ESTATE ON CHARLES RIVER).

MAY 2, 1907.

To MR. HENRY G. OPDYCKE, C.E., *92 Liberty Street, New York.*

DEAR SIR: — The State Board of Health has considered your plans for the disposal of the sewage from an estate bordering on the Charles River in Dover, and has caused the locality to be examined by one of its engineers.

The plans provide for receiving the sewage into a septic tank which will hold about 3,800 gallons, whence it is to be discharged upon two filters having an aggregate area of about 200 square feet, the effluent therefrom to be discharged into the Charles River. It is understood that the works will be enclosed in a building.

This plan is, in the opinion of the Board, unlikely to effect efficient purification of the sewage unless the effluent shall be given further treatment by filtration. It is probable that better and more satisfactory results could be obtained in this case and at less expense by the construction of cesspools in gravelly soil, of which there appears to be an abundance in the locality, or by applying the sewage after passing through a tank or cesspool to a system of subsurface drains, as is done in the case of the sewage of Wellesley College, the disposal area of which is located a short distance away on the opposite side of the Charles River.

The Board would recommend the adoption of either of these methods instead of the one proposed, if the soil in the neighborhood available for this purpose is of coarse sand or gravel, as the appearance of the surface indicates.

FRANKLIN.

JAN. 23, 1907.

To the Sewerage Committee of the Town of Franklin.

GENTLEMEN: — The State Board of Health received from you on Dec. 5, 1906, an application for advice with reference to a proposed system of sewage disposal for the town of Franklin, accompanied by a plan and a report of your engineer showing the proposed location of the main sewer and filter beds and describing the proposed works.

The plan provides for collecting the sewage in a main sewer to be laid in the valley of Mine Brook, through which it will be conveyed to a filtration area below the village of Unionville, where it is proposed to purify it by intermittent filtration and discharge the effluent into the brook. Two locations for filter beds are shown on the plan submitted, — one on the easterly and the other on the westerly side of Mine Brook, — and at each location 12 filter beds, aggregating about 5 acres in area, are shown upon the plans.

The Board has caused the locality to be examined by its engineer and has examined the plans and other information presented therewith.

The main sewer is of sufficient capacity to remove all of the sewage of the portions of the village that will be tributary thereto, together with the objectionable portions of the manufacturing wastes which now pollute the streams, and if properly constructed will be of sufficient capacity to allow for an increase in the quantity of sewage and manufacturing wastes in the future. The sewer for a considerable portion of its length in the neighborhood of Mine Brook is to be constructed of iron pipe with lead joints, — a desirable provision, under the circumstances, since it is of the greatest importance that the sewer be made as tight as possible so as to limit the quantity of water entering it and consequently the area necessary for the purification of the sewage.

The filtration areas shown on the plans are located on either side of Mine Brook a short distance below Unionville. No test pits have been dug at either of the proposed locations to show the character of the soil, but, judging from material exposed in an excavation on the westerly area and from other indications, it is likely that the soil in much of this area is of good quality for the purification of sewage, and it is also somewhat more nearly level and in other respects the more desirable of the two. Portions of the filter beds, if constructed on the westerly side of the brook as proposed, would extend over an adjacent meadow, but suitable material for the construction of the filters can probably be obtained from the upland near by. Further investigations will be necessary before the best plan of constructing filters can be definitely determined upon.

In the opinion of the Board, the plan, in general, is an appropriate one, so far as can be judged from the information presented, for collecting and disposing of the sewage of the portion of Franklin which it is designed to serve, and the area of filter beds indicated, if constructed of suitable material, is likely to be sufficient for the requirements of the town in the beginning. Care must be taken in admitting manufacturing wastes to the sewers to exclude all matters which might cause trouble in the operation of the sewers or filter beds.

The Board would recommend that the construction of the works for the collection and disposal of the sewage be begun without delay and the further serious pollution of the waters of Mine Brook prevented.

GROTON.

SEPT. 5, 1907.

To the Board of Health of the Town of Groton, HERBERT B. PRIEST, M.D., *Secretary.*

GENTLEMEN: — In response to your request for an examination of the condition of James Brook, running through the village of Groton, and advice as to the prevention of its further pollution, the Board has caused the locality to be examined by one of its engineers.

The results of the examination show that the brook is considerably polluted at the present time, chiefly by sink drainage and the overflow of cesspools, and that the channel of the stream is crooked and in places badly obstructed, forming pools which become stagnant in the summer season.

The Board would recommend that the channel of the stream be deepened and straightened and hereafter kept clear so as to avoid the formation of stagnant pools in dry weather. It is probable that under present conditions the sewage from the houses can be disposed of in cesspools, if properly constructed and arranged, so that serious pollution of the brook will be avoided. It is doubtful, however, whether this stream can long be maintained in proper sanitary condition unless sewers shall be provided for the removal of sewage from its neighborhood. The construction and maintenance of proper cesspools will be a considerable expense to the individual owners along the stream, and the most satisfactory plan of preventing further nuisance from this stream will probably be to construct sewers in the beginning.

If you decide to proceed with the construction of a sewerage system for the district in the valley of this brook the Board will, upon request, advise you as to any plan for the collection and disposal of the sewage which you may desire to present.

HATFIELD.

MAY 2, 1907.

To Messrs. DAVID BILLINGS, C. EDWARD WARNER and T. J. RYAN, *Board of Selectmen of the Town of Hatfield.*

GENTLEMEN: — The State Board of Health has considered your application, received March 29, for advice as to plans of a system of sewers to be constructed in a portion of the village of Hatfield and has caused the locality to be examined by one of its engineers.

It appears that several years ago a plan of sewerage for the village was prepared which provides for the collection of the sewage and of the surface water from several of the streets in the main portion of the village into a system of pipe sewers having outlets into the Connecticut River at two points, one at the old ferry road near the northerly end of the village and the other at the old bridge road near its southerly end. It further appears that a sewer for surface drainage was laid last year in the upper part of Main Street having an outlet through the old ferry road which discharges upon the river bank above low water.

It is understood that you now propose to construct a main outlet for the southerly part of the village through the old bridge road, and to connect with it tributary sewers in Main, Maple and Elm streets, and that you desire the advice of the Board as to this portion of the plan and also as to connecting the houses along upper Main Street — about fifteen in number — with the main drain constructed in that street last year, which discharges into the Connecticut River through the old ferry road.

In the opinion of the Board the proposed plan of disposing of the sewage of the village by discharging it into the Connecticut River is the best that it is practicable to adopt, and with properly constructed outlets this method of disposal is unlikely to become objectionable for many years in the future. The proposed points of discharge are well located, but it will be necessary that the outlets be carried out into the river beyond the limits of extreme low water in order to avoid fouling the shores.

While surface drainage appears to be greatly needed in the village, especially along Main Street, it is doubtful whether the proposed sewers would have sufficient capacity to remove all of the surface water and sewage which might enter them at times of rain unless the areas from which surface water is received shall be restricted, and it would be better to keep the drainage channels separate from the sewers. Most of the necessary surface drainage in the village could apparently be provided for very largely by means of open drainage channels and short surface-water conduits, and if the surface water should be kept out of the sewers much smaller sewers than those now proposed will be sufficient for the removal of the sewage. This plan would also be more satisfactory in maintaining cleaner sewers, since, if sewage should be discharged into the large drains now proposed, the flow would be very small in comparison with the capacity of the sewers, and sand and detritus carried into the sewer at times of storm might, with the small flow of sewage, cause the sewers to become foul in dry weather. Since a storm-water drain has already been laid in upper Main Street to an outlet through the old ferry road, it will probably be best, for the present at least, to provide for sewerage in this region by connecting the house sewers with this drain; but provision should be made for flushing the sewer in dry weather whenever necessary to keep it clean, and the outlet should be extended beyond low water in the river before it is used as a sewer. The size of this sewer is not sufficient to remove promptly all of the storm water that might find its way into it from the street and the other areas which might be drained by it, and care must be taken to limit the areas from which water is discharged into this sewer in order to avoid overcharging it at times of storm.

The Board would also call attention to the necessity of keeping all fixtures in houses connected with sewers discharging into the river at a sufficiently high elevation above the highest freshet level to avoid danger of sewage being forced back into the houses through the fixtures.

Sept. 5, 1907.

To the Board of Sewer Commissioners of the Town of Hatfield.

Gentlemen: — The State Board of Health received from you on July 18, 1907, a modified plan showing certain amendments in the plans of sewerage for the village of Hatfield designed to overcome the objections to the plans as presented in March last.

By the plans now submitted it is proposed to divert the storm water from all those portions of Main Street north of the town hall, which by the former plan were to discharge into the Connecticut River at the old bridge road, through a separate storm-water drain leading through School Street to the brook discharging into Mill River. The sewer north of the town hall, as now planned, will receive house sewage only, but south of the town hall it is proposed to provide for receiving, in addition to the house sewage, the drainage from seven catch-basins located along Main Street between the town hall and the corner of Elm Street, — the mingled sewage and rain water to be discharged into the Connecticut River through the old bridge road. It is not proposed to discharge roof water from any of the buildings into the sewers, but to divert it, so far as possible, to the rear of the buildings and restrict the quantity of water admitted to the proposed sewer to that which would be received from a district about 15 rods in width, extending from the town hall to the junction of Main and Elm streets. It is also proposed that no fixtures or openings of any kind shall be allowed in buildings below the level of the first floor.

The Board has caused the locality to be examined by its engineer and has carefully considered the plan presented.

It will be practicable by this plan to disconnect the catch-basins from the proposed sewer at any time, and effect a complete separation of the sewage from the storm water by constructing an independent storm-water drain to the river.

The sewers are of adequate size to remove the storm water and sewage from the limited area which they are designed to serve, and, considering all the circumstances, the Board is of the opinion that the plan is a reasonable one for providing sewerage and drainage in the village of Hatfield at the present time. It will be necessary under this plan to flush the main sewer from time to time in dry weather to prevent objectionable odors arising from the catch-basins, and this can probably best be done by providing suitable connections with the water mains at the time the sewers are built.

The Board would recommend that the outlet of the sewer in the Connecticut River be carried beyond low-water mark, so that it will be covered with water at all stages of the river.

HAVERHILL.

Nov. 7, 1907.

To Hon. ROSWELL L. WOOD, *Mayor, Haverhill, Mass.*

DEAR SIR: — The State Board of Health has considered your application for advice relative to a proposed plan of sewerage for the district in the neighborhood of Keeley Street in the village of Riverside, which provides for a combined system of sewers having an outlet into the Merrimack River at a point near the limit of extreme low water, and has caused the locality to be examined by one of its engineers.

The district to be served by the proposed sewer is a limited one, having an area of only about 37 acres, which is at present thinly populated, and the proposed sewers are probably large enough to remove both sewage and storm water from the area which they are designed to serve under existing conditions. As the district becomes more thickly built up the storm water will enter the sewers more rapidly, and further provision for the drainage of this district will become necessary.

The proposed plan of placing the outlet of the sewer at extreme low-water mark is a satisfactory one under the existing conditions, but the Board would advise that the outlet of the pipe be entirely submerged at extreme low water. When the district becomes more densely populated it may be desirable to extend the outlet farther into the river and provide a storm overflow near the bank of the stream, and these changes can be made without difficulty if found desirable.

In the opinion of the Board, the plan is a suitable one for the sewerage and drainage of the district for which it is designed.

HYDE PARK (TILESTON & HOLLINGSWORTH COMPANY).

JULY 9, 1907.

To the Tileston & Hollingsworth Company, Mattapan, Mass.

GENTLEMEN: — The State Board of Health has received from your engineer plans of a proposed system of sedimentation tanks and filters for the purification of the wastes which are now discharged into the Neponset River from your mill, accompanied by a report describing the proposed works and giving the results of measurements of the quantities of the wastes proposed to be purified thereby.

The wastes to be purified, according to that report, are those discharged from the paper machines, amounting ordinarily to about 200,000 gallons per day, those from the washing machines, amounting to from 132,000 to 400,000 gallons per day, and an additional quantity of waste from the save-alls of the paper machines, the amount of which is variable but may reach 200,000 gallons per day, — the total amount of waste thus varying from about 332,000 gallons to as much as 800,000 gallons per day.

The plans provide for conveying the wastes from the washing machines, amounting to from 132,000 to 400,000 gallons per day, to a sedimentation tank — indicated on the plan as the "washer wastes tank" — 56 feet long and 31 feet wide, and designed to hold 8 feet in depth of water, its total capacity being about 100,000 gallons. The washing-machine wastes are to be allowed to settle in this tank, and the overflow or effluent thereof is to be discharged upon adjacent filter beds having an area of approximately half an acre. The filtering material is to consist of screened cinders 30 inches in depth over a system of underdrainage discharging into the river.

The wastes from the paper machines are to be discharged into a settling tank divided into three compartments, and indicated upon the plans as the "machine-wastes tank." Each compartment is to be 30 feet 6 inches by 36 feet 2 inches, and will contain a depth of 8 feet of water. The total capacity of the three compartments will be a little under 200,000 gallons. The piping is to be so arranged that two of the compartments can be used while one of them is being cleaned.

The overflow from these tanks is to be passed either into the settling basin for river water now used in connection with the mechanical filter plant, which has a capacity of 200,000 gallons, or directly to the mechanical filters, and after filtration will either be used again upon the paper machines or discharged into the river. Provision is made whereby the water used in cleaning the mechanical filters can be pumped back into the washer-wastes tank.

The solid matter collecting in the tanks is to be flushed out from time to time upon the cinder filters, using them for the time being as sludge beds, and when dry is to be carted away.

The Board has considered the plans presented and the results of experiments made upon the purification of a portion of the wastes from this mill. It appears that the area of land available is very limited, and that the whole area has been utilized for tanks and filter beds in the plans now presented. This area is so limited that it will require much care to dispose satisfactorily of the wastes of the mill upon it, but while the quantity of these wastes is no greater than at the present time it is probable that they can be purified satisfactorily by care in the management of the tanks and filters.

There are two ways in which it will be possible to increase the efficiency of the works, and the Board would suggest that they be given consideration in the construction and operation of the works. One is, the straining of the wastes passing through the sedimentation tanks through strainers filled with coke so placed that they can be hoisted, the coke removed and the strainer refilled and replaced from time to time as may be necessary. This coke can probably be disposed of satisfactorily, together with the intercepted solid matter, by burning it under the boilers. Another possible way of increasing the efficiency of the works will be to divert some of the wastes from the washer-wastes tank to the mechanical filters, and thus reduce the quantity which it is necessary to discharge upon the cinder filters.

Three of the cinder filters should be set apart for use as sludge beds, and only these should be used for that purpose. It will be practicable, also, when they are not in use for sludge, to use them for ordinary filters. The sludge should be removed promptly as soon as dry, in order that the full use of the beds may be secured, and the material in the beds will have to be raked and renewed from time to time in order to keep the filters in the proper condition.

The Board is of the opinion that, if the works shall be constructed, as proposed, of suitable materials, and operated with proper care, they will purify efficiently the wastes from this mill while the quantity is no greater than at the present time, as shown by the measurements of your engineer.

LEXINGTON.

FEB. 14, 1907.

To Messrs. ROBERT P. CLAPP, GEORGE O. WHITING and F. W. DEAN, *Board of Sewer Commissioners of the Town of Lexington.*

GENTLEMEN: — The State Board of Health received from you on Jan. 9, 1907, a petition bearing that date which refers to the communication of the Board, dated April 16, 1898, approving a system of sewerage for the town of Lexington, and requesting modifications of certain requirements included by the Board in that approval for the purpose of protecting the purity of the water supply of the town of Arlington.

After notice to the board of water commissioners of the town of Arlington and the board of public works of that town a hearing was held by the Board on Thursday, Feb. 7, 1907, at which were present the chairman of the board of public works of the town of Arlington, with the town counsel, and the members of your board, with their engineer.

It appears that the water from the Arlington reservoir — through the watershed of which the main sewer of the town of Lexington and certain branch sewers will necessarily be constructed — has not been used or supplied by that town for domestic purposes for several years, but the town of Arlington is not yet prepared to abandon it as a source of water supply.

Under the circumstances, in the opinion of the Board, the following provisions, contained in the approval of the plans and construction of a proposed sewerage system for Lexington, dated April 16, 1898, may reasonably be suspended: —

> The town of Lexington, in contracting for the construction of its sewers, will cause to be inserted in the contract substantially the following provisions: —
>
> The contractor at his expense shall provide proper sanitaries.
>
> No sanitary to be located within 100 feet of any brook tributary to the Arlington water supply.
>
> The engineer may designate the position of the sanitaries.
>
> Sanitaries shall be left in one location as short a time as possible, and on removal all foul matter shall be removed to such location as the engineer designates, and there buried.
>
> The contractor must see that the men employed on the work use the proper sanitaries provided for them.
>
> No sanitary to be put over the sewer trench within the territory tributary to Arlington's water supply.

The Board suspends the foregoing requirements in the building of the sewers in the watershed of the Arlington reservoir during the year 1907 and for such further period as the water of the reservoir may remain unused, as at present; provided that in their place the town of Lexington, in contracting for the construction of its sewers, will cause to be inserted in its contracts such provisions as are usual or necessary to secure proper sanitary conditions on or about the work and to prevent the pollution of local waters.

In regard to the further request contained in your petition desiring a modification of that part of the Board's approval of the Lexington sewerage plans in 1898 which provides that the portions of the main and intercepting sewer which lie between the junction of Pleasant Street and Massachusetts Avenue and Vine Street shall be constructed of iron pipe, with carefully made lead joints, the Board hereby modifies said requirements and requires that iron pipe with lead joints be employed only in such of said portions of that sewer as shall have more than one-third in cross section above the ground water at its ordinary summer level, the remainder of said sewer, where as much as two-thirds of the sewer in cross section shall lie below the level of the ground water, to be constructed of vitrified sewer pipe with cement joints.

With the exception of the modifications herein specified, the provisions and requirements of the communication of this Board to the board of sewer commissioners of the town of Lexington, dated April 16, 1898, shall remain in force.

LOWELL.

JULY 9, 1907.

To the Committee on Sewers of the City of Lowell, MR. GEORGE BOWERS, *City Engineer.*

GENTLEMEN: — The State Board of Health received from you on June 6, 1907, a communication stating that on June 3 "it was voted to instruct the city engineer to ask advice of the State Board of Health in regard to the proper method of draining that part of the city known as the Oaklands," and subsequently a plan was submitted showing the sewers at the Oaklands, and stating that the plan of disposal is to collect the sewage into a small concrete basin, to be built on land owned by the city of Lowell, and pump the same either by gasoline or electric motor into the Wentworth Avenue sewer, now discharging into the Merrimack River.

The Board has caused the locality to be examined by its engineer and has considered the plans presented. There is no doubt, in the opinion of the Board, that the method adopted for the sewerage and drainage of the district of Oaklands by providing separate systems of sewers, one for storm water and one for sewage, is the best and most economical for the city to adopt. The surface water and ground drainage collected in the surface-water sewers can without objection be discharged into Trull Brook at convenient points, as is being done at the present time.

The discharge of sewage from the present system of sewers into the head of Trull Brook at Rogers Street greatly pollutes the brook, and the nuisance which it causes will rapidly grow worse as the number of connections with the sewers increases.

The best practicable plan of preventing this nuisance, in the opinion of the Board, is to pump the sewage from the domestic sewers of this district into one of the main sewers discharging into the Merrimack River, as is proposed in the plan submitted, and the Board would recommend that the pumps and other necessary works be installed as soon as practicable in order to prevent further nuisance and danger to health from the pollution of Trull Brook.

MILFORD.

JUNE 6, 1907.

To the Sewerage Committee of the Town of Milford, Mr. J. E. WARNER, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on May 13, 1907, the following communication relative to the necessity of constructing sewers in the low-level district of Milford bordering the Charles River: —

> The town of Milford has proceeded toward the completion of its sewerage system in accordance with the plans on file in your office so far as to have nearly completed the disposal plant and the high-level intercepting sewer, and contracts are let and work is in progress for the construction of sewers covering the main street and numerous adjacent side streets of the high-level district.
>
> As yet nothing has been done in sewering the low-level district lying along the river, — the sewage of which must be pumped. In this district are situated the large factories and a thickly settled area now served by privies and draining directly or indirectly into the stream.
>
> The work already undertaken will remove from the river the sewage now entering it through the Central and Main Street sewers from the higher portion of the town, but, as already stated, makes no provision for such pollution of the stream as arises from the area lying below the elevation of the high-level interceptor.
>
> It has been the intention of the sewerage committee to proceed with the construction of the low-level district and to ask the town for the additional appropriation necessary for this work. Before doing this, however, we desire the opinion of your Board as to the necessity of this additional construction, and whether the work already undertaken will remove such portion of the sewage as to reduce the contamination of the river to a degree making unnecessary the sewering of the low-level district.

The Board has caused the locality to be examined by one of its engineers, and has considered the plan of sewerage for the town presented last year and the probable effect on the river of omitting for the present the construction of the low-level sewer and pumping station.

The present pollution of Charles River at and below Milford and the nuisance resulting therefrom are due to the discharge of sewage from two local sewers and from several factories and numerous dwelling houses situated along the river in the lower part of the town.

The most objectionable unsanitary conditions found in Milford are in the district to be served by the low-level sewer, and, while a considerable portion of the sewage which now pollutes the river would be diverted by the gravity, or high-level, sewer already under construction, the very serious pollution of the river and objectionable conditions in the lower part of the town will continue until sewers are provided as proposed in that district.

In the opinion of the Board, it is necessary for the town to proceed immediately with the construction of the system of sewers for the low-level district.

NEWBURYPORT.

SEPT. 5, 1907.

To Hon. ALBERT F. HUNT, *Mayor of the City of Newburyport.*

DEAR SIR: — The State Board of Health received from the superintendent of sewers of the city of Newburyport, on Aug. 29, 1907, the following application relative to the discharge of sewage into the Merrimack River at Currier's wharf from a small district in the city containing eight houses: —

> The city of Newburyport wishes to change the sewer from Forrester Street to Ashland Street on Merrimac Street, and to put an outlet into the Merrimack River passing through the city's right of way down Currier's wharf, the end extending into the river 20 feet.
>
> As the sewer is at present, it runs from Ashland Street to Forrester Street, then it is pumped into the main sewer by a water motor which seldom, if ever, works, and necessitates it being pumped by hand, making considerable expense to the city. At present there are only three houses connected with this sewer, and if every building along this sewer were connected, there would only be eight.
>
> The plan of this sewer has been sent you.
>
> We want to change the grade of the sewer to run from Forrester to Ashland Street and thence into the river.

The Board has considered the application and the plan submitted therewith, and has caused the locality to be examined by its engineer, and concludes that the sewage from the very limited area and population in question can be discharged into the Merrimack River at a point 25 feet from the shore at low water at Currier's wharf, as indicated upon the plan, without objection while the conditions continue as at present.

The Board, acting under the provisions of chapter 233 of the Acts of the year 1889, hereby approves the discharge of the sewage into the Merrimack River at the point indicated from the district as described in your application, with the understanding that the sewage shall be removed from the river and the outlet discontinued within ten years from the date hereof, unless, on account of objectionable conditions arising, its earlier removal shall be required by the State Board of Health.

NORWOOD.

MARCH 9, 1907.

To Messrs. M. M. ALDEN, C. B. SANBORN and P. J. LYDON, *Sewer Commissioners of the Town of Norwood.*

GENTLEMEN: — The State Board of Health received from you on Jan. 19, 1907, the following application for the approval of certain plans of a system of sewerage for the town of Norwood: —

> In accordance with section 16 of chapter 311 of the Acts of 1901, entitled "An act to authorize the town of Norwood to construct a system of sewerage," the board of sewer commissioners of said town of Norwood herewith submit for the approval of the State Board of Health plans for a system of sewerage for the town of Norwood.

The application is accompanied by plans and a report describing the proposed system of sewerage and sewage disposal.

The plans provide for collecting the sewage of the thickly settled portions of the town, including the sewage of the present Norwood sewer, into a system of pipe sewers through which it is to be conveyed by gravity to a filtration area on the borders of the Fowl Meadows south of the Neponset River and east of Pleasant Street, where it is to be purified by intermittent filtration, the effluent to be discharged into the Neponset River.

Certain areas in the valley of Purgatory Brook and its neighborhood, and in the valley of the Neponset River near the mouth of Hawes Brook, are too low to be served by the proposed system by gravity, and the plans provide for pumping the sewage from these areas, when sewerage becomes necessary, into the main system, the locations of the proposed pumping stations being indicated on the plan submitted, — one on the westerly side of Neponset Street between Pleasant Street and East Cross Street and the other on Pleasant Street just north of the Neponset River.

Acting under the provisions of section 16 of chapter 311 of the Acts of the year 1901, the State Board of Health gave a hearing at its office, Room 143, State House, on Thursday, Feb. 7, 1907, at which no person appeared to oppose the approval of the plans.

The Board has carefully examined the plans presented and finds that they provide for all of the areas in the town of Norwood which are now in need of sewerage or are likely to require sewerage facilities for a long time in the future. They also provide for removing all of the sewage from the present town sewer discharging into the Neponset River and from the various manufacturing establishments in and about the village from which sewage now finds its way into the stream. The plan does not make provision for taking the foul drainage from the tannery of the Winslow Brothers & Smith Company in the valley of Hawes Brook, but this company has already begun the construction of works for the purification of its manufacturing wastes. It may be necessary at some future time to take a part or all of the drainage or effluent from these works into the Norwood system, but, considering the circumstances, it does not appear to be necessary at present to plan for a sewer in the Hawes Brook valley large enough to receive these wastes.

The location of the filter beds is a very satisfactory one for the purposes proposed, since it is near the edge of the Fowl Meadows, remote from the thickly populated parts of the town. The soil of this area, as determined by examinations in previous years, is excellent for the purification of sewage, and an ample area is available for the purpose.

The Board approves the plan in general as a practicable one for the collection and disposal of the sewage of Norwood, but would recommend that certain details of the plan presented be given further consideration before the construction of the work is finally entered upon.

It is especially desirable to avoid, if possible, the construction of the piers and embankment along the main sewer between Dean Street and the filtration area, and it is also desirable to lay the main sewer in Dean Street and near Pleasant Street north of Dean Street at a lower level. It is probable that by constructing the main sewer and the lower portions of the two main tributaries of iron pipe in the form of an inverted siphon the sewage can be conveyed to the filtration area without difficulty and delivered there at a somewhat higher level than under the present plan.

It is also desirable to provide, in addition to the dosing tank, a settling tank for the removal of a portion of the solid matter, as it will reduce the expense of operating the beds if some of the heavier solids should first be separated from the sewage.

As already stated, it may be possible, by using an inverted siphon, to bring the sewage to the filtration area at a somewhat higher level, and it is also practicable to construct some of the higher beds as now proposed at a somewhat lower level.

These changes will probably increase slightly the cost of the system, but will have a tendency to reduce the difficulty and expense of maintenance.

Only one outlet for sewage is indicated upon each of the beds — which are 200 feet long and 100 feet wide, — but it is understood that it is proposed to discharge the sewage through a trough laid through the middle of the bed. This plan will give satisfactory results, so far as the dosing of the beds is concerned. A more satisfactory plan, and one which requires less care in maintenance, is to discharge the sewage through at least four outlets, two on each side of the bed.

The underdrainage system appears sufficient for the proper drainage of the filter beds. It would be best to put the manholes at the junction of the lateral underdrains, with the main underdrain in the embankments between the beds, and the vents at the upper ends of the underdrains may be omitted. It would be desirable to place the underdrains in the filter beds a little nearer the center.

Considering the ample area of filter beds available, it will be desirable, in the beginning at least, to omit the construction of the row of beds nearest the street, substituting therefor an equal area at a greater distance from the highway. By planting trees thickly around the northerly and westerly sides of the filter beds the presence of the filtration area will not be detectable from any of the highways in the region.

SALEM.

SEPT. 5, 1907.

To the Board of Sewerage Commissioners of the City of Salem.

GENTLEMEN: — The State Board of Health received from you on July 31, 1907, an application for the approval by this Board, under the provisions of section 1 of chapter 353 of the Acts of 1901, of the plans of certain trunk sewers which are described in your application, as follows: —

It is proposed to build a trunk sewer beginning at the westerly end of Derby Street, which is the terminus of the present Derby Street sewer, and extending by Central Street to Lafayette Street, thence by Lafayette Street, Dodge Street, Washington Street and Canal Street to Ocean Avenue.

For the district east of Lafayette Street it is proposed to build a trunk sewer beginning at Dodge Street and extending by Lafayette Street to Peabody Street, thence by Peabody Street, Harbor Street, Congress Street, Palmer Street, Prince Street, Lagrange Street, thence by private land to Glover Street, thence by Glover Street and across a cove to Ocean Avenue. The accompanying plan shows the sizes and grades of the proposed sewer, also the proposed extensions southerly.

These sewers are designed for house sewage.

It is proposed to connect the easterly end of the Derby Street sewer with the sewer that extends to the pumping station.

These proposed sewers can be extended to receive sewage from the territory up to the Marblehead boundary.

The application is accompanied by a plan and profiles of the proposed sewers, and further information has been submitted showing the areas from which, with subsequent extensions, they are designed to receive and remove sewage.

The Board has caused the location of the proposed sewers to be examined by its engineer and has considered the plans presented, and concludes that sewers built in accordance with the proposed plans will provide for the removal and proper disposal of the sewage of the districts in Salem which they are designed to serve.

Large portions of the district in which these sewers will be built are already provided with sewers, built upon the combined plan, which receive both sewage and storm water. It is a part of your plan to gradually separate the sewage from the storm water in these districts, and it is very important, in the opinion of the Board, that this plan be adhered to and carried out as rapidly as practicable in order to prevent the further pollution of the harbor and South River and their shores by sewage or manufacturing waste.

The Board hereby approves the plans presented.

SOUTHBRIDGE.

SEPT. 5, 1907.

To Messrs. H. C. CADY, W. J. LAMOUREUX and JAMES K. EGAN, *Sewerage Commissioners of the Town of Southbridge.*

GENTLEMEN: — The State Board of Health received from you on August 28 an application requesting the approval of new purification works for the sewage of the town of Southbridge, to be located in the valley of Trout Brook, half a mile or more below the present filter beds, accompanied by a plan showing an outline of the proposed works and by a description of contemplated changes in the present system submitted by your engineer.

In accordance with the provisions of chapter 228 of the Acts of 1899, the Board gave a hearing at its office, Room 143, State House, on Thursday, Sept. 5, 1907, notice of said hearing having been published in newspapers circulating in the town of Southbridge. At this hearing a plan for the proposed system was presented by the petitioners and described by a representative of your board and your engineer.

After the hearing the Board voted to approve the plan presented, the said plan bearing the following title: "Southbridge Sewerage System. Plan of Proposed Sewage Disposal Works. Scale 1 inch = 40 feet. August 24th, 1907. Wm. S. Johnson, Consulting Engineer, 101 Tremont St., Boston, Mass. Sewer Commissioners, Henry C. Cady, W. J. Lamoureux, James K. Egan. J. A. Whittaker, Engineer, Southbridge, Mass."

The location of the beds is a satisfactory one, and by maintaining the present growth of trees between the filtration area and the highway leading through the valley of Trout Brook no objection is likely to arise from the construction and operation of sewage-disposal works in this locality.

The area of filter beds provided for under this plan is sufficient for the present requirements of Southbridge, and will provide for the disposal of the sewage for a considerable time in the future. The area is limited, however, and it is of great importance that all surface water and, so far as possible, ground drainage be carefully excluded from the sewers to avoid overtaxing the filter beds. It is also important that the works be constructed in a thorough and substantial manner, so that they can be operated to the best advantage and at as high a rate as practicable, and that they shall be properly operated.

STOUGHTON (FRENCH & WARD).

AUG. 1, 1907.

To Messrs. FRENCH & WARD, *West Stoughton, Mass.*

GENTLEMEN: — The State Board of Health received, through your engineer, on July 26, 1907, an application giving an outline of a proposed scheme for purifying the wastes from your mill, accompanied by a plan showing the location of the proposed works and the area of filter beds to be provided. The proposed works are described as follows: —

It is proposed to collect all of the wastes from the cloth washers and from the dye kettles and to convey them through a 6-inch pipe by gravity to sand filter beds. These filter beds, two in number, are to have a combined area of one-half an acre. The beds will be underdrained by lines of tile pipe 3.5 feet beneath the surface of the sand.

The fall from the factory to the filter beds is very small, and it is proposed to omit the settling tanks, for the present at least, and to construct in place of these a small basin, about a foot in depth, on each filter bed which will receive the wastes discharged from the 6-inch pipe, and from which they will overflow to the main portion of the bed, these basins being designed to intercept the heaviest portion of the solid matter and thus prevent the necessity of frequent raking of the entire area of the bed.

The total quantity of foul wastes, as found by measurements made by your engineers, amounts to 30,000 gallons per day, and with the filter beds proposed the rate of filtration will be 60,000 gallons per day. If it is found desirable at some future time, a settling tank can be constructed, the overflow to discharge on the filter beds, and the contents of the tank can be emptied upon beds constructed of cinders at a lower level.

The Board has caused the locality to be examined and has considered the plan presented.

At the time the measurement referred to above was made the total quantity of waste from this mill amounted to about 60,000 gallons per day, of which only from 30,000 to 40,000 gallons was at that time being seriously polluted.

If the total quantity of waste in the future shall not exceed 30,000 to 40,000 gallons per day it is probable, in the opinion of the Board, that it can be adequately purified upon the area of filter beds indicated, unless the character of the wastes shall change materially from what they are at present.

It is proposed to provide for sedimentation by passing the wastes through a small basin 20 feet square and about 1 foot deep on each filter bed, from which the effluent will overflow upon the filter. It is desirable that further provision for the sedimentation of the wastes be made than is provided in the plan, and the Board would advise that the settling basins on the beds be increased to at least twice the capacity of those now proposed.

TAUNTON.

AUG. 1, 1907.

To the Board of Sewer Commissioners of the City of Taunton.

GENTLEMEN: — The State Board of Health has considered your request of July 1, 1907, for a further extension of the time for the completion of the main intercepting sewer, planned to convey the sewage now discharged into the Taunton River from the present sewer outlets to a new temporary outlet at the location of the proposed pumping station, and the information furnished therewith showing that the contract for the construction of the proposed sewer has already been made and that the date specified for the completion of the work is Oct. 31, 1907.

The Board hereby extends the time for the completion of the proposed intercepting sewer to the new temporary outlet at the pumping station lot to Oct. 31, 1907.

The Board has also considered the further extension of the time for the completion of the sewerage and sewage-disposal works, as provided in the plans approved by order of this Board July 15, 1897, and hereby extends the time within which all the sewage from the sections of the said city on the westerly side of the Taunton River shown upon the map entitled "Map of a section of the City of Taunton for Proposed Sewerage System. Luther Dean, City Engineer, 1897," filed with the petition of the sewer commissioners in 1897, shall be disposed of upon land upon the Assonet Neck Road, described in a communication from said commissioners to this Board dated June 16, 1897, to the first day of July, 1910.

The Board would call your attention to the fact that the pollution of the Taunton River has been increasing rapidly within the last few years, and that it is improbable that the discharge of sewage into the river can safely be continued beyond the time herein specified. This will leave but two full working seasons in which to construct the pumping station, force main and filter beds, provide pumps and other machinery and do the other necessary work incidental to the removal of the sewage from the Taunton River. It is advisable, under the circumstances, that preparations for the construction of these works should be taken up very soon in order that construction may be begun in season to allow for the completion of the works within the time specified.

WALPOLE (HOLLINGSWORTH & VOSE).

JULY 9, 1907.

To the Hollingsworth & Vose Company, East Walpole, Mass.

GENTLEMEN: — The State Board of Health has received from your engineer plans of a proposed system of sedimentation tanks, filters and evaporating tanks for the purification of the wastes which are now discharged into the Neponset River from your mill, accompanied by a report describing the proposed works and giving an estimate of the quantities of waste to be purified thereby.

The wastes to be purified, according to that report, are, first, wastes from the machines used in making paper, amounting to about 1,000,000 gallons per day; second, wastes from the washers and beaters, amounting on an average to about 500,000 gallons per day but at times to approximately twice that quantity; and third, wastes from the rotary boilers used for boiling stock, which amount to from 35,000 to 40,000 gallons per day.

The plan for purifying the wastes from the paper machines provides for passing these wastes through preliminary save-alls and a screen for the recovery of stock, and thence to a tank in the basement, whence it is to be pumped to a large settling tank located outside of the mill buildings, having a depth of 10 feet and a capacity of 250,000 gallons. This tank is to be divided into four compartments, so arranged that the waste liquid can be discharged into any one of the compartments and passed through each of them in rotation. After passing through this tank the overflow is to be delivered to mechanical filters, and after filtration to be used again for manufacturing purposes in the mill.

All of the wastes from the washers, beaters and drainers are to be discharged into a settling tank having a capacity of 400,000 gallons, or a little less than the average day's flow from the mill. From this tank the liquid is to be passed to filter beds of cinders or of sand and gravel obtained at the site, the effluent to be discharged into the river. Sludge beds are provided for receiving the sludge from this settling tank and from the settling tank receiving the machine wastes, the dried sludge to be removed to some convenient place of disposal.

The Board has examined the plans presented and the results of experiments upon the purification of wastes from this mill, and concludes that this plan, exclusive of the portion relating to the disposal of the boiler wastes, is in general a satisfactory one for the purification of the wastes from this mill. The area of cinder and sand filters proposed will, in the opinion of the Board, be capable of treating a quantity amounting to 590,000 gallons per day, — the average quantity of wastes from the drainers and machines for washing stock. There will, however, be considerable fluctuation in the quantity of waste, and the quantity may be much larger than the average for a period of several days. Moreover, there will be a considerable quantity of washings from the mechanical filters, which must be cared for on the proposed cinder and sand filters, and, under the circumstances, the Board would recommend that the proposed area be increased by at least one acre.

While the purification of the machine wastes by the use of mechanical filters will probably be the best method of dealing with these wastes at the present time, it is not unlikely that if the condition of the river improves very materially above your mill it will be better to discontinue mechanical filtration of at least a part of these wastes and divert them instead to cinder or sand filters. This, however, is a matter for future consideration, but should be kept in mind in the construction of the works.

For the treatment of the boiler wastes, the plans submitted provide for the construction of 12 tanks each 15 feet by 30 feet and 5 feet in depth, designed to hold 4 feet in depth of liquid. The total evaporating surface would be 5,400 square feet. The amount of evaporation of the boiler waste that can be obtained in these tanks is doubtless variable, but the tanks must be of sufficient capacity to evaporate the full amount at the time of minimum evaporation. It will probably be necessary if this system should be followed to increase greatly the area of the evaporating tanks. If a sufficient area should be provided it is probable that these wastes could be disposed of by this plan. Considerable odor might be given off from these evaporating tanks, though their location is such that the odors are unlikely to be noticeable at any dwelling house in the neighborhood. The sludge from these tanks can probably be disposed of in the same manner as the sludge from the proposed tanks receiving the other wastes, but the area of the sludge bed should be much larger than is indicated on the plan.

WINCHESTER.

FEB. 11, 1907.

To Messrs. FRANK E. ROWE, WILLIAM E. BEGGS, WILLIAM D. RICHARDS and Others, *Winchester, Mass.*

GENTLEMEN: — The State Board of Health received from you on Dec. 31, 1906, a petition representing that the condition of Russel Brook, so called, situated partly in Woburn and partly in Winchester, is so foul as to be a menace to health at all times, especially in the summer season, and that it is necessary that some method of purifying the stream and its banks be undertaken as soon as possible to improve existing conditions; and you request the Board to examine the brook and its surroundings and advise as to the best method of improving it.

The attention of the Board was called to the condition of Russel Brook in 1904 by the board of health of Winchester, and, after an examination, the Board replied as follows: —

> The State Board of Health received from you on Sept. 14, 1904, a communication requesting the Board to take some action relative to a nuisance caused by Russel Brook in Winchester, in which you state: —
>
> > We desire hereby to formally complain to the State Board of Health of the dangerous nuisance existing in Winchester, caused by the pollution of Russel Brook by sundry parties in Woburn allowing their sewage, consisting of decomposing fleshings and vat refuse, the odor from which is beyond description, to therein drain. Complaints from people abutting on the brook have been numerous and justifiable to this board, that the conditions resulting are unbearable, and a direct menace, in the opinion of this board, to their health and that of the entire community.
>
> In response to your request, the Board has caused the locality to be examined by its engineer and samples of the water of the stream collected at several points in Woburn and Winchester to be analyzed.
>
> The results of the examinations show that the brook receives foul wastes from the Robertson tannery on Eastern Avenue, that other polluting matters are evidently discharged into it by tanneries located between Prospect Street and John Street in Woburn, and that the stream where it enters Winchester

was badly polluted and had a very foul odor at the time this examination was made, on September 27.

The liquid wastes from the various tanneries which now pollute the stream can be kept out of the stream and disposed of by discharging them into the sewers, which were designed for the removal of these wastes as well as for the domestic sewage of this region.

In the opinion of the State Board of Health, the nuisance of which you complain can be prevented by action of the Woburn board of health under existing laws, and the attention of that board has been called to the results of the investigation of September 27.

A communication was also sent at that time to the board of health of the city of Woburn, a copy of which is appended hereto.

A recent examination of Russel Brook shows that Robertson's tannery is now connected with the Woburn sewers, but the tanneries along the brook still discharge directly or indirectly considerable quantities of waste into the stream. Although some effort has evidently been made to prevent polluting matters from entering the stream, its bed and banks are discolored, and there appears to be little change in the character of the water since the time of the previous investigation.

As the source of the nuisance caused by Russel Brook in Winchester is outside of that town there appears to be no practicable way of preventing the pollution of the stream under existing laws except by action of the board of health of Woburn or by appeal to the courts.

WINTHROP.

JULY 9, 1907.

To the Board of Health of the Town of Winthrop, MR. B. H. METCALF, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on June 3, 1907, the following communication, requesting the advice of this Board as to the prevention of a nuisance caused by a sewer outlet in the town of Winthrop: —

> We wish as a Board to call your attention to a condition of things in regard to sewerage in a section of Winthrop which we as a Board have tried to change. At the southwest side of the town is a large area which has been sewered by a private drain running on to the beach. This drain was constructed nearly twenty years ago, before the town system was built. At that time and for many years only three used this; since that time seven more have been built and several more are contemplated. This territory is so low that the town sewer any where near this point is not accessible. This private drain has become a nuisance endangering health and should be discontinued.
>
> We had the town engineer draw plans and make specifications to construct sewer across the marsh land in rear of Washington Avenue, some 2,800 feet

away, at a cost approximately $8,000, to a point where the metropolitan sewer was accessible. An article was placed in the town warrant for the meeting to be held May 16, but it was almost unanimously voted to defer any action in the matter until the next annual town meeting, in March, 1908.

We cannot see what further steps can be taken in this matter to abate this nuisance, and we feel called upon to ask the interference or advice of your honorable Board in the matter.

An examination of the locality shows that the only practicable plan of disposing of this sewage and preventing the nuisance upon the shore is either to pump it into the neighboring town sewer or to convey it by gravity directly to the metropolitan sewer. The length of force main necessary to connect with the town sewer would be only about 250 feet, but it would be necessary to provide and maintain a pump which could be operated by an oil engine or electric power if the latter is available, and the yearly cost of care and maintenance would be a considerable item. While the distance to the metropolitan sewer is as much as 2,800 feet, and the initial cost of conveying the sewage to that sewer would be considerable, that plan is likely in the long run, in the opinion of the Board, to be the most satisfactory and least expensive method of disposing of the sewage from the district in question, and the Board believes it would be the better plan for the town to adopt.

It is important, in any case, that action be taken without delay to divert the sewage from the present outlet, where it pollutes the shores and waters of the harbor, and unless this action shall be taken before the end of the current year, it will become the duty of the Board, under the provisions of existing laws, to report the matter to the Legislature for action.

MISCELLANEOUS.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to miscellaneous matters: —

BURLINGTON (MULLER BROTHERS).

Nov. 7, 1907.

To Messrs. MULLER BROTHERS, *Burlington, Mass.*

GENTLEMEN: — In response to a petition from certain residents of Burlington and Lexington, alleging that a nuisance detrimental to the health of the residents in the neighborhood arises from the rendering establishment conducted by your firm, and desiring action by this Board for its abatement, the Board, after notice, gave a hearing at its office on Sept. 5, 1907, at which both the petitioners and your firm were represented, and has caused the works to be examined by its engineer.

It is evident that seriously objectionable odors from the factory are noticeable at times in its neighborhood, and an examination shows that no adequate provision is made there for destroying or deodorizing the waste steam and gases discharged from the various processes, nor even such provision as is usually made for preventing the escape of objectionable odors from such establishments.

The building is of wood and very difficult to keep clean, and the doors and windows of the factory were open when visited, allowing odors therefrom to escape freely into the atmosphere; but the works are located in a thinly settled neighborhood, and if suitable provisions for ventilation and for burning or otherwise destroying the odors from the various processes carried on therein should be made, and the factory kept as clean as possible, it can probably continue to be used without causing a nuisance in the neighborhood.

The Board would recommend that the changes necessary to prevent the escape of offensive odors from the works be made without delay, and that provision be made for the proper ventilation of all buildings in which processes giving rise to an objectionable odor are carried on, or in which offensive material is stored.

The Board does not find that the method of disposing of the drainage is objectionable at the present time.

LYNN (GEORGE E. MARSH COMPANY).

MARCH 7, 1907.

To The George E. Marsh Company, Lynn, Mass.

GENTLEMEN: — In response to a petition from certain residents in the neighborhood of your rendering works in the city of Lynn, alleging the existence of a nuisance by reason of offensive odors therefrom, the State Board of Health has given a public hearing, at which you were represented, and has examined the works and their surroundings.

The information collected shows that odors resulting from the processes carried on in these works are noticeable at long distances from the factory, and are very offensive to residents in the neighborhood, especially in the summer season, and the Board notifies you that measures must be taken promptly to prevent this nuisance.

LYNN (ILLINOIS LEATHER COMPANY).

NOV. 7, 1907.

To the Illinois Leather Company, Lynn, Mass.

GENTLEMEN: — In response to a petition from numerous residents in the neighborhood of your factory in Lynn, alleging that the escape of noxious odors and dust therefrom is a menace to the comfort and convenience of the public and causes a public nuisance, the State Board of Health, after notice, gave a public hearing at its office on Sept. 5, 1907, at which the petitioners and your corporation were represented. The

Board has also caused the factory and its surroundings to be examined by its engineer and has considered the evidence and information presented.

It appears that the processes carried on in the factory are the washing, carding and shipping of hair brought to the factory in carts from various tanneries. The wastes from these processes are, chiefly, dust, which is collected in dust chambers provided therefor from which there is a vent discharging through the roof, and waste water, discharged from the machines used for washing the hair, which contains large quantities of lime and dirt. This waste water is pumped to settling tanks from which the supernatant liquid is discharged into the Lynn sewers, while the sediment is discharged upon the ground at the edge of a swamp in the rear of the factory.

It is evident that much dust and hair escape from the factory in various ways, especially from an open chute through which hair is conveyed from one building to another, from the open windows of the factory, which are not screened, from sweepings from floors and from the wagons in which the hair is brought, which are dumped outside the factory. There is no doubt also that a very considerable quantity of dust escapes from the pipe leading from the dust chambers, which discharges above the roof of the factory.

In the opinion of the Board, the health and comfort of the inhabitants of this neighborhood require that further and more thorough precautions be taken for preventing the escape of dust and hair from this factory. This can be done without very serious difficulty by providing for the dumping of the hair brought to the factory in a shed or other structure, properly covered and enclosed, by covering the chute leading between the buildings so that no hair can escape therefrom, by discharging the pipe from the dust chambers under the boiler fires or disposing of this dust in some other way so that it will not escape into the atmosphere, by screening the windows with fine screens and by providing for the proper disposal of all sweepings.

The present method of disposing of the sludge from the settling tanks is unsightly and objectionable, the sludge, which contains the sewage of the operatives, being discharged into a swamp covered with a dense growth of vegetation. The Board would recommend that proper sludge beds be constructed of gravel, coarse sand or cinders, surrounded with embankments to keep the sludge from escaping, and that after drying the material be removed and dumped at some suitable place, where it should be covered with sufficient clean filling to prevent danger that lime dust therefrom may be blown about the neighborhood.

The Board also recommends that the sewage of the operatives be discharged through a separate pipe directly into the sewers.

MEDFORD (METROPOLITAN PARK COMMISSION).

JAN. 3, 1907.

To the Board of Metropolitan Park Commissioners.

GENTLEMEN: — The State Board of Health having considered the plans presented by you for a dam in the Mystic River at Cradock Bridge, and acting under the requirements of chapter 445 of the Acts of 1904, hereby approves of the same as being consistent with the improvement and purification of Mystic River and Alewife Brook.

The plans presented are five in number and bear the following titles: —

"Metropolitan Park Commission. Mystic River Reservation. Contour Map of a Portion of Mystic River Basin. Lower Mystic Lake to Cradock Bridge. Medford, Arlington & Somerville." Dated November, 1906, and signed by John R. Rablin, engineer.

"Sheet No. 1. Commonwealth of Massachusetts. Metropolitan Park Commission. Mystic River Reservation. Plan showing Location of Proposed Dam at Cradock Bridge. Medford, Mass. Scale 1 in. = 100 ft. June 22, 1906. John R. Rablin, Engineer."

Sheets Nos. 2, 3 and 4. "Metropolitan Park Commission. Mystic River Reservation. Dam at Cradock Bridge. Medford, Mass. June 22, 1906. John R. Rablin, Engineer."

SOMERVILLE (HINCKLEY RENDERING WORKS).

MARCH 7, 1907.

To The Hinckley Rendering Company, Somerville, Mass.

GENTLEMEN: — A further examination of your works and the conditions about them shows that odors are noticeable at long distances from the factory, and are such as to be very offensive to residents in the neighborhood, especially in the summer season.

The Board notifies you that measures must be taken promptly to prevent this nuisance.

SEPT. 5, 1907.

To the Consolidated Rendering Company, 40 North Market Street, Boston, Mass.

GENTLEMEN: — The State Board of Health has considered your application for advice as to certain proposed improvements at the Hinckley Rendering Works in Somerville, with a view to preventing the nuisance therefrom, which are described by your engineer as follows: —

> I would recommend the construction of a water tower having an area of 200 square feet and a height of 60 feet, to be located back of the factory over the river. Baffle-boards should be placed every 18 inches through the entire height of the tower, these baffle-boards to be 7/8-inch stock laid on edge, 7/8 of an inch apart. The stock used for this purpose can be ordinary

furring. The pumping plant should be increased so that at least 200 gallons per minute can be discharged in the form of spray at the top of the tower. The bottom of the tower should rest on stone foundation, and the water should be discharged from the tower at a point considerably below high-water level, and, preferably, below the low-water mark.

A 7-foot fan should be installed to collect the vapors and gases from the various machines and discharge them into the bottom of the tower. An entire new system of air ducts should be constructed, and the hoods over the machines should be repaired, and, in some instances, new hoods should be built. In all cases the hoods should be extended down toward the floor far enough to prevent the escape into the air of any of the vapors when the windows are open and there is a draft through the room, and if necessary doors can be provided in the sides of the hoods to give access to the machines. In addition to the hoods already in use, hoods should be provided over all places where the tankage is exposed and it may be desirable to provide a hood over the bone dryers. In the case of the concentrated tankage dryers, it would be well to enclose the machines in a separate room without windows and thoroughly ventilated.

It is possible that it may be found desirable to collect certain of the worst of the gases and discharge them beneath the boilers, but, owing to the favorable location of the factory, it seems unlikely that this will be necessary. Probably the worst odors come from the concentrated tankage dryers, and if necessary these can be collected by the aid of a small fan and discharged beneath the boilers.

The basement of the building is foul smelling, chiefly because it is not ventilated, but it is evident that this portion of the building contributes but little to the odors produced outside, so that it does not seem necessary to provide ventilation. The principal causes of the odors in the basement are the tanks, and it would not be a very difficult matter to provide hoods for these tanks if necessary. I would not advise, however, doing this, in the beginning at least.

A 7-foot fan, making 204 revolutions per minute, would have a capacity of 35,000 cubic feet of air per minute. Assuming that half of the capacity of the fan is lost by friction in the air ducts, in the tower and in other ways, such a fan should be sufficient to change all of the air in the two main floors of the factory, where most of the objectionable odors are produced, once in thirteen minutes.

The water discharged from the tower and from the suction tees which is not discharged into the sewer should be carried into the river below low-water level. This will prevent, in a large measure, the occurrence of objectionable odors and unsightly appearance along the shore of the stream at low water.

The Board has caused the works to be examined by its engineer and has carefully considered the plans presented.

Recent visits to these works show that, while some improvement has been made since the first complaints were received, objectionable odors still escape from them, especially in the summer season.

Under present conditions much of the odor escapes through the windows and a part of the remainder through a number of ventilators located just above the roof. A small part of the more objectionable odors are passed through a tower, through which a stream of water is allowed to fall, and are discharged but slightly above the roof of the building. The water, moreover, passed down through this tower is discharged above low water in the river, and in this way doubtless some odor escapes.

This tower is insufficient for the purpose, and, moreover, does not receive all of the odors from some of the places which it is designed to serve. By collecting all of the odors in the manner now proposed, passing them into a higher tower with its top well above the roof of the factory, and using a much larger quantity of water with the point of discharge below low tide in the river, it is probable that the odor escaping from this building will be diminished. It is impossible to determine whether enough odor would still escape to be noticeable at dwelling houses in the neighborhood or not.

If, after the changes suggested are made, objectionable odors still escape from the factory to such an extent as to be noticeable at dwelling houses in the neighborhood, other arrangements will have to be made, and it may be necessary to pass part or all of the odors through a fire sufficient for their destruction.

In carrying out a scheme for preventing a nuisance from this factory much will depend upon the proper construction of the works and the care with which they are operated.

Public Institutions.

The following is the substance of the action of the Board during the year in reply to applications for advice under the provisions of section 4 of chapter 75 of the Revised Laws: —

Bridgewater and Rutland (State Prison).

Dec. 5, 1907.

To the Board of Prison Commissioners, State House, Boston, Mr. Frederick G. Pettigrove, *Chairman.*

Gentlemen: — The State Board of Health received from you on Nov. 29, 1907, a communication requesting its opinion as to the expediency of locating a State prison either on land belonging to the Commonwealth at the State Farm in Bridgewater or on certain land belonging to the Commonwealth in the town of Rutland, being a tract of about 1,000 acres, taken several years ago for the purposes of an industrial camp for prisoners; and the Board has considered each location with a view to its possible use for the purpose indicated.

The location of the temporary industrial camp for prisoners at Rutland is, as its name indicates, a temporary one, and was occupied a little over three years ago with the intention that it was to be used for about ten years. The location is within the watershed of the Ware River, one of the sources of water supply designated for the future use of the metropolitan district and the city of Worcester, and it is not desirable, in the opinion of the Board, to locate a large public institution permanently in that watershed.

At Bridgewater some unusual expenses would be involved in the question of obtaining a suitable water supply as well as an efficient system of sewage disposal, but with such expenditures these necessities can be provided.

EXAMINATION OF PUBLIC WATER SUPPLIES.

EXAMINATION OF PUBLIC WATER SUPPLIES.

The number of sources of public water supply in use during the year 1907 was 267. Of these, 53 were natural lakes and ponds, 68 were storage reservoirs, 46 were streams and 100 were wells, filter galleries and other ground waters.

The usual chemical analyses of the principal sources of supply have been made during the year and are presented in the two following tables, the first of which contains characteristic analyses of the surface-water supplies and the second the averages of analyses of samples from the ground-water supplies.

Averages of Chemical Analyses of Surface-water Sources for the Year 1907.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.			Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
				Free.	ALBUMINOID.			Nitrates.	Nitrites.		
					Total.	Sus-pended.					
Metropolitan Water District.	Wachusett Reservoir, upper end.	.31	3.42	.0018	.0138	.0020	0.25	.0032	.0001	.39	0.6
	Wachusett Reservoir, surface, near dam.	.18	3.09	.0021	.0127	.0027	0.25	.0024	.0001	.30	0.7
	Wachusett Reservoir, bottom, near dam.	.18	3.14	.0022	.0120	.0020	0.25	.0038	.0001	.30	0.7
	Wachusett Aqueduct, .	.25	3.42	.0023	.0129	.0017	0.25	.0048	.0001	.37	1.0
	Sudbury Reservoir, .	.19	3.42	.0033	.0133	.0023	0.27	.0045	.0001	.30	1.0
	Framingham Reservoir No. 3.	.17	3.31	.0027	.0143	.0035	0.28	.0035	.0001	.30	1.1
	Hopkinton Reservoir, .	.55	3.90	.0020	.0175	.0024	0.35	.0026	.0001	.63	1.0
	Ashland Reservoir, .	.59	3.84	.0020	.0191	.0031	0.29	.0022	.0001	.65	0.8
	Framingham Reservoir No. 2.	.65	4.34	.0021	.0194	.0019	0.33	.0028	.0001	.72	1.0
	Lake Cochituate, . .	.24	5.19	.0036	.0233	.0057	0.51	.0030	.0001	.42	2.0
	Chestnut Hill Reservoir.	.24	3.49	.0023	.0140	.0023	0.29	.0053	.0001	.34	1.1
	Weston Reservoir, .	.16	3.56	.0019	.0118	.0022	0.27	.0055	.0002	.28	1.2
	Dug Pond, . . .	.13	5.01	.0074	.0273	.0073	0.64	.0028	.0002	.33	1.8
	Spot Pond, . . .	.13	3.30	.0020	.0137	.0018	0.32	.0025	.0001	.26	1.2
	Tap in State House, .	.22	3.79	.0015	.0131	.0020	0.32	.0066	.0001	.32	1.2
	Tap in Revere, . .	.11	3.62	.0013	.0121	.0015	0.32	.0030	.0001	.27	1.3
	Tap in Quincy, . .	.19	3.64	.0011	.0115	.0012	0.34	.0071	.0001	.30	1.3
Abington, . . .	Big Sandy Pond, . .	.09	3.12	.0029	.0168	.0032	0.66	.0018	.0001	.21	0.5
	Little Sandy Pond,[1] .	.01	3.70	.0018	.0192	.0064	1.06	.0013	.0000	.21	0.3
	Oldham Pond, . .	.24	3.58	.0025	.0186	.0026	0.66	.0012	.0001	.35	0.3

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[1] Not used directly.

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Amherst,	Amethyst Brook Reservoir.	0.21	2.76	.0010	.0086	.0015	0.13	.0022	.0001	0.28	0.5
	Lower Reservoir,	0.34	3.33	.0011	.0083	.0009	0.13	.0030	.0001	0.40	0.5
Andover,	Haggett's Pond,	0.15	3.25	.0012	.0149	.0016	0.33	.0019	.0000	0.28	1.1
Ashburnham,	Naukeag Reservoir,	0.02	2.70	.0018	.0026	.0002	0.15	.0180	.0000	0.03	1.0
Athol,	Phillipston Reservoir,	0.65	3.53	.0144	.0220	.0061	0.16	.0062	.0001	0.66	0.5
	Buckman Brook Reservoir.	0.29	3.08	.0020	.0164	.0054	0.13	.0023	.0000	0.47	0.4
Barre,	Reservoir,	0.18	3.18	.0025	.0171	.0028	0.14	.0024	.0001	0.29	0.7
Braintree,	Little Pond,	0.28	4.20	.0036	.0228	.0022	0.89	.0110	.0002	0.40	1.3
Brockton,	Salisbury Brook Reservoir.[1]	0.51	3.99	.0026	.0223	.0043	0.42	.0010	.0001	0.62	0.7
	Silver Lake,	0.10	3.03	.0012	.0111	.0021	0.61	.0010	.0000	0.20	0.4
Cambridge,	Upper Hobbs Brook Reservoir.	0.49	5.64	.0043	.0304	.0070	0.40	.0088	.0001	0.64	2.1
	Lower Hobbs Brook Reservoir.	0.14	5.02	.0033	.0234	.0040	0.39	.0024	.0001	0.35	2.1
	Stony Brook Reservoir,	0.36	5.65	.0032	.0197	.0022	0.48	.0108	.0002	0.50	2.2
	Fresh Pond,	0.25	6.14	.0059	.0270	.0099	0.56	.0149	.0005	0.42	2.9
Cheshire,	Thunder Brook,	0.05	3.65	.0002	.0026	.0006	0.06	.0030	.0001	0.09	2.2
	Kitchen Brook,	0.03	3.20	.0004	.0020	.0004	0.06	.0070	.0001	0.08	2.6
Chester,	Austin Brook Reservoir.	0.12	2.95	.0004	.0042	.0004	0.10	.0010	.0001	0.17	1.0
Cohasset,	Lily Pond,	1.34	6.30	.0031	.0332	.0071	1.16	.0017	.0000	1.42	0.9
Concord,	Sandy Pond,	0.04	2.95	.0013	.0125	.0029	0.28	.0014	.0001	0.13	0.6
Dalton,	Egypt Brook Reservoir.	0.36	3.66	.0017	.0098	.0014	0.08	.0190	.0000	0.54	1.2
	Lower Reservoir,	0.32	3.10	.0014	.0084	.0010	0.09	.0120	.0000	0.43	1.4
Danvers,	Middleton Pond,	0.50	4.04	.0019	.0186	.0029	0.37	.0008	.0001	0.62	1.1
Deerfield,	Roaring Brook,	0.04	5.80	.0014	.0018	.0002	0.07	.0060	.0000	0.06	3.4
Easthampton,	Bassett Brook,	0.36	4.20	.0025	.0127	.0029	0.13	.0055	.0000	0.44	1.3
Fall River,	North Watuppa Lake,	0.19	3.56	.0015	.0171	.0019	0.57	.0024	.0000	0.35	0.7
Falmouth,	Long Pond,	0.04	2.77	.0007	.0094	.0015	0.91	.0007	.0000	0.08	0.3
Fitchburg,	Meetinghouse Pond,	0.07	2.97	.0029	.0111	.0019	0.15	.0023	.0001	0.15	0.6
	Scott Reservoir,	0.16	2.43	.0021	.0145	.0042	0.15	.0027	.0001	0.27	0.4
	Wachusett Lake,	0.12	2.62	.0023	.0125	.0024	0.15	.0018	.0001	0.19	0.3
	Falulah Reservoir,	0.15	2.95	.0006	.0058	.0008	0.14	.0030	.0000	0.23	0.5
Gardner,	Crystal Lake,	0.09	3.97	.0026	.0173	.0034	0.29	.0033	.0001	0.22	1.5
Gloucester,	Dike's Brook Reservoir.	0.50	4.27	.0026	.0170	.0032	0.92	.0017	.0001	0.42	0.3
	Wallace Reservoir,	0.52	4.67	.0026	.0194	.0037	1.19	.0011	.0001	0.53	0.4

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[1] Not used.

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Gloucester,	Haskell Brook Reservoir.	.61	4.29	.0088	.0136	.0019	.87	.0018	.0001	.46	0.3
Great Barrington,	East Mountain Reservoir.	.10	4.77	.0046	.0072	.0014	.10	.0008	.0000	.16	2.9
	Green River,	.01	9.86	.0007	.0041	.0010	.09	.0158	.0000	.06	7.2
Greenfield,	Upper reservoir on Glen Brook.	.07	5.27	.0013	.0074	.0016	.12	.0056	.0000	.12	3.0
	Lower reservoir on Glen Brook.	.08	5.03	.0012	.0068	.0020	.12	.0057	.0001	.09	3.0
Hadley,	Hart's Brook Reservoir.	.10	4.30	.0012	.0103	.0033	.15	.0010	.0000	.14	2.3
Hatfield,	Reservoir,	.19	4.03	.0014	.0087	.0030	.14	.0148	.0000	.28	1.6
Haverhill,	Johnson's Pond,	.16	4.52	.0016	.0162	.0019	.39	.0015	.0001	.29	2.0
	Crystal Lake,	.18	3.30	.0026	.0160	.0012	.27	.0015	.0001	.32	1.0
	Kenoza Lake,	.16	4.01	.0023	.0158	.0021	.38	.0011	.0001	.30	1.8
	Lake Saltonstall,	.08	5.88	.0028	.0166	.0035	.58	.0013	.0001	.17	2.7
	Lake Pentucket,	.13	5.01	.0017	.0160	.0018	.76	.0015	.0001	.28	1.7
	Millvale Reservoir,	.60	5.05	.0028	.0185	.0020	.36	.0026	.0001	.70	1.8
Hingham,	Accord Pond,	.19	3.11	.0018	.0127	.0013	.65	.0011	.0001	.31	0.4
Holden,	Muschopauge Lake,	.06	3.04	.0017	.0117	.0026	.25	.0093	.0000	.15	0.7
Holyoke,	Whiting Street Reservoir.	.08	3.95	.0030	.0186	.0030	.17	.0010	.0001	.19	2.1
	Fomer Reservoir,	.30	3.87	.0013	.0125	.0020	.14	.0027	.0001	.38	1.3
	Wright and Ashley Pond.	.13	5.18	.0048	.0193	.0035	.18	.0018	.0001	.26	2.6
	High-service Reservoir,	.13	5.72	.0022	.0264	.0056	.18	.0010	.0001	.45	2.2
Hudson,	Gates Pond,	.15	2.96	.0033	.0159	.0024	.22	.0018	.0001	.26	0.7
	Fosgate Brook,	.51	3.85	.0009	.0104	.0006	.21	.0030	.0001	.52	0.9
Huntington,	Cold Brook Reservoir,	.15	2.79	.0007	.0059	.0006	.12	.0012	.0000	.21	0.9
Ipswich,	Dow's Brook Reservoir,	.19	4.60	.0023	.0167	.0030	.63	.0032	.0001	.32	1.7
Lawrence,	Merrimack River, filtered.	.39	5.04	.0118	.0100	.0014	.35	.0214	.0002	.44	1.8
	Distributing Reservoir,	.35	4.88	.0059	.0101	.0012	.35	.0177	.0002	.43	1.6
Lee,	Upper reservoir on Codding Brook.	.23	2.52	.0042	.0259	.0064	.13	.0017	.0001	.41	0.7
	Lower reservoir on Codding Brook.	.19	3.05	.0009	.0105	.0016	.09	.0030	.0001	.28	1.4
	Basin Pond Brook,	.34	4.00	.0020	.0115	.0015	.08	.0037	.0000	.45	1.6
Lenox,	Reservoir,	.08	7.61	.0014	.0074	.0018	.10	.0062	.0001	.12	6.2
Leominster,	Morse Reservoir,	.21	2.31	.0030	.0181	.0028	.16	.0015	.0001	.28	0.2
	Haynes Reservoir,	.23	2.74	.0095	.0276	.0074	.15	.0011	.0001	.30	0.1
	Fall Brook Reservoir,	.13	2.33	.0013	.0142	.0034	.16	.0010	.0001	.24	0.2
Longmeadow,	Cooley Brook,	.06	4.55	.0044	.0058	.0010	.16	.0300	.0002	.01	2.7

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid.			Nitrates.	Nitrites.		
					Total.	Suspended.					
Lynn, . . .	Birch Reservoir, .	0.34	4.22	.0052	.0218	.0051	0.57	.0041	.0001	0.42	1.3
	Breed's Reservoir, .	0.57	4.91	.0054	.0206	.0043	0.60	.0064	.0001	0.61	1.3
	Walden Reservoir, .	0.44	4.51	.0047	.0215	.0037	0.59	.0035	.0001	0.53	1.4
	Hawkes Reservoir, .	0.53	5.42	.0050	.0246	.0037	0.59	.0037	.0001	0.62	1.8
	Saugus River, . .	1.02	8.59	.0061	.0325	.0039	0.83	.0016	.0002	1.12	4.0
Marlborough, . .	Lake Williams, . .	0.11	4.04	.0026	.0176	.0025	0.50	.0008	.0001	0.21	1.5
	Millham Brook Reservoir.	0.45	4.57	.0041	.0199	.0038	0.37	.0056	.0001	0.45	1.4
Maynard, . . .	White Pond, . .	0.27	3.44	.0013	.0106	.0010	0.27	.0060	.0000	0.31	1.0
Milford, . . .	Charles River, filtered,	0.16	3.57	.0009	.0063	–	0.31	.0179	.0001	0.21	1.1
Montague, . .	Lake Pleasant, . .	0.07	2.44	.0034	.0081	.0017	0.13	.0020	.0000	0.11	0.4
Nantucket, . .	Wannacomet Pond, .	0.07	5.77	.0029	.0202	.0091	2.04	.0008	.0001	0.13	1.2
New Bedford, . .	Old Storage Reservoir,[1]	1.38	5.42	.0044	.0278	.0040	0.56	.0022	.0001	1.23	1.0
	Little Quittacas Pond,	0.34	3.71	.0027	.0180	.0030	0.54	.0012	.0000	0.46	0.7
	Great Quittacas Pond,	0.46	3.72	.0018	.0168	.0022	0.53	.0007	.0000	0.58	0.6
North Adams, . .	Notch Brook Reservoir,	0.05	7.03	.0029	.0093	.0031	0.08	.0023	.0001	0.10	5.8
	Broad Brook, . .	0.19	3.37	.0018	.0070	.0009	0.07	.0180	.0000	0.31	1.6
Northampton, . .	Middle Reservoir, .	0.31	3.62	.0016	.0116	.0028	0.10	.0025	.0001	0.36	1.5
	Mountain Street Reservoir.	0.10	4.10	.0010	.0079	.0021	0.09	.0017	.0001	0.18	1.7
	West Brook, . .	0.17	4.76	.0009	.0060	.0009	0.09	.0046	.0001	0.22	1.8
North Andover, .	Great Pond, . . .	0.14	3.76	.0023	.0157	.0016	0.37	.0014	.0000	0.30	1.5
Northborough, .	Lower Reservoir, .	0.59	3.60	.0044	.0283	.0106	0.22	.0022	.0001	0.61	0.6
Northbridge, . .	Cook Allen Reservoir,	0.24	2.65	.0034	.0134	.0030	0.18	.0010	.0001	0.31	0.3
Norwood, . . .	Buckmaster Pond, .	0.12	3.50	.0126	.0135	.0031	0.49	.0023	.0001	0.15	1.0
Palmer, . . .	Lower Reservoir, .	0.12	2.79	.0022	.0093	.0026	0.14	.0028	.0001	0.16	0.4
Peabody, . . .	Brown's Pond, . .	0.16	3.64	.0023	.0166	.0033	0.67	.0029	.0001	0.27	1.1
	Spring Pond, . .	0.12	6.74	.0084	.0137	.0028	0.68	.0076	.0003	0.22	2.7
	Suntaug Lake, . .	0.07	4.21	.0027	.0162	.0022	0.69	.0023	.0001	0.16	1.9
Pittsfield, . . .	Ashley Lake, . .	0.25	5.38	.0047	.0141	.0016	0.09	.0072	.0001	0.35	3.4
	Ashley Brook, . .	0.18	6.77	.0052	.0126	.0023	0.12	.0067	.0002	0.30	4.7
	Hathaway Brook, .	0.03	9.59	.0006	.0039	.0005	0.08	.0165	.0000	0.10	8.2
	Mill Brook, . . .	0.09	5.20	.0009	.0052	.0009	0.07	.0080	.0001	0.14	3.6
	Sacket Brook, . .	0.07	6.95	.0028	.0062	.0018	0.09	.0145	.0000	0.13	5.6
Plymouth, . .	Little South Pond, .	0.02	2.59	.0010	.0148	.0025	0.66	.0004	.0000	0.10	0.1

[1] Not used.

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid. Total.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
Plymouth, . .	Great South Pond, .	0.02	2.44	.0009	.0116	.0014	0.63	.0004	.0000	0.09	0.1
	Boot Pond, . . .	0.02	2.32	.0010	.0138	.0014	0.61	.0030	.0000	0.10	0.1
Randolph, . .	Great Pond, . . .	0.49	4.61	.0021	.0189	.0029	0.70	.0047	.0001	0.54	1.2
Rockport, . . .	Cape Pond, . . .	0.24	8.95	.0036	.0248	.0087	3.09	.0007	.0000	0.33	1.7
Salem, . . .	Wenham Lake, . .	0.28	5.86	.0073	.0217	.0050	0.85	.0051	.0002	0.43	2.1
	Longham Reservoir, .	1.28	6.52	.0074	.0373	.0081	0.94	.0050	.0001	1.03	1.7
Southbridge, . .	Hatchet Brook Reservoir No. 3.	0.34	3.06	.0028	.0235	.0059	0.16	.0018	.0001	0.42	0.6
	Hatchet Brook Reservoir No. 4.	0.48	3.40	.0052	.0309	.0096	0.18	.0010	.0001	0.56	0.7
South Hadley, . .	Leaping Well Reservoir.	0.07	2.76	.0061	.0147	.0068	0.15	.0108	.0002	0.10	0.7
	Buttery Brook Reservoir.	0.19	3.87	.0036	.0086	.0034	0.22	.0232	.0004	0.15	0.9
Spencer, . . .	Shaw Pond, . . .	0.07	2.84	.0008	.0124	.0011	0.17	.0020	.0000	0.15	0.9
Springfield, . .	Ludlow Basin, . .	0.24	2.86	.0016	.0138	.0026	0.14	.0027	.0002	0.30	0.7
	Ludlow Canal, . .	0.42	3.40	.0016	.0142	.0022	0.16	.0028	.0001	0.45	0.7
	Ludlow Reservoir, .	0.27	3.02	.0045	.0219	.0073	0.15	.0016	.0001	0.32	0.7
	Chapin Pond,[1] . .	0.05	2.23	.0037	.0199	.0041	0.11	.0012	.0000	0.19	0.3
	Five Mile Pond,[1] . .	0.08	2.62	.0023	.0187	.0030	0.13	.0012	.0001	0.18	0.3
	Loon Pond,[1] . . .	0.03	2.82	.0021	.0177	.0027	0.24	.0014	.0001	0.16	0.6
	Borden Brook,[1] . .	0.54	3.61	.0009	.0122	.0014	0.10	.0019	.0001	0.63	0.9
	Pebble Brook,[1] . .	0.44	3.14	.0013	.0137	.0017	0.10	.0017	.0001	0.56	0.9
	Westfield Little River,[1]	0.46	3.22	.0011	.0131	.0017	0.11	.0024	.0001	0.55	0.8
Stockbridge, . .	Lake Averic, . .	0.14	7.04	.0037	.0210	.0047	0.08	.0028	.0002	0.29	4.8
Taunton, . . .	Assawompsett Pond, .	0.33	3.32	.0019	.0169	.0022	0.53	.0011	.0001	0.48	0.4
	Elder's Pond, . .	0.11	2.92	.0011	.0144	.0017	0.51	.0011	.0000	0.28	0.4
	Long Pond, . . .	–	–	–	–	–	–	–	–	–	–
Wakefield, . .	Crystal Lake, . .	0.21	4.90	.0055	.0174	.0030	0.56	.0066	.0002	0.28	1.8
Wareham, . .	Jonathan's Pond, .	0.00	2.61	.0008	.0074	.0009	0.67	.0012	.0000	0.07	0.1
Wayland, . . .	Snake Brook Reservoir,	0.75	4.96	.0037	.0191	.0018	0.37	.0141	.0001	0.64	1.6
Westborough, . .	Upper Sandra Pond, .	0.21	2.57	.0020	.0208	.0068	0.22	.0012	.0000	0.33	0.3
	Lower Sandra Pond, .	0.02	3.44	.0022	.0092	.0027	0.22	.0007	.0001	0.10	1.3
Westfield, . .	Montgomery Reservoir,	0.48	2.87	.0033	.0185	.0041	0.11	0018	.0001	0.55	0.2
	Tillotson Brook, . .	0.16	3.02	.0022	.0065	.0012	0.14	.0028	.0001	0.21	0.5
	Tekoa Reservoir, .	0.38	2.67	.0027	.0139	.0028	0.13	.0023	.0001	0.43	0.3
West Springfield, .	Darby Brook Reservoir,	0.21	4.56	.0072	.0137	.0060	0.23	.0094	.0001	0.24	2.3

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[1] Not used.

Averages of Chemical Analyses of Surface-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid.			Nitrates.	Nitrites.		
					Total.	Sus-pended.					
West Springfield, .	Bear Hole Brook, filtered.	.07	7.00	.0008	.0048	–	.19	.0032	.0000	.12	4.1
Weymouth, . .	Great Pond, . . .	.85	4.24	.0030	.0179	.0021	.56	.0021	.0000	.84	0.6
Williamsburg, . .	Reservoir, . . .	.20	3.70	.0020	.0062	.0011	.09	.0022	.0000	.20	1.4
Winchester, . .	North Reservoir, . .	.09	4.03	.0051	.0197	.0046	.43	.0014	.0001	.24	1.5
	South Reservoir, . .	.14	3.57	.0074	.0180	.0025	.37	.0017	.0001	.24	1.4
	Middle Reservoir,[1] .	.19	3.81	.0078	.0274	.0055	.39	.0011	.0001	.33	1.3
Woburn, . . .	Horn Pond, . . .	.27	7.51	.0065	.0227	.0052	.97	.0399	.0008	.40	3.1
Worcester, . .	Bottomly Reservoir, .	.22	3.58	.0028	.0180	.0032	.21	.0121	.0002	.40	1.2
	Kent Reservoir, . .	.18	3.55	.0017	.0155	.0024	.20	.0076	.0001	.31	1.1
	Leicester Reservoir, .	.18	3.37	.0032	.0127	.0022	.21	.0056	.0001	.30	1.0
	Mann Reservoir, . .	.17	4.30	.0016	.0151	.0045	.20	.0090	.0002	.31	1.1
	Upper Holden Reservoir.	.13	2.50	.0015	.0112	.0026	.17	.0021	.0001	.23	0.3
	Lower Holden Reservoir.	.09	2.44	.0020	.0124	.0024	.17	.0014	.0001	.18	0.5

[1] Not used directly.

Averages of Chemical Analyses of Ground-water Sources for the Year 1907.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron,
				Free.	Albu-minoid.		Nitrates.	Nitrites.			
Amesbury, . .	Main Street wells, . .	.32	12.41	.0007	.0013	0.72	.0128	.0001	.02	6.3	.2000
	Market Street wells, . .	.01	27.51	.0032	.0022	1.47	.0052	.0001	.04	16.5	.0101
Attleborough, .	Old well, ...	.00	4.92	.0007	.0021	0.39	.0092	.0000	.05	2.1	.0107
	New well, ...	.01	4.83	.0005	.0021	0.37	.0077	.0000	.06	1.9	.0083
Avon, . . .	Well, ...	.00	5.22	.0003	.0023	0.49	.0707	.0000	.01	1.8	.0045
Ayer, . . .	Large well, ...	.01	5.24	.0004	.0020	0.57	.0222	.0000	.02	2.3	.0104
	Tubular wells, . . .	.01	4.73	.0006	.0009	0.15	.0033	.0000	.00	1.9	.0117
Billerica, . .	Tubular wells, . . .	.15	6.44	.0014	.0033	0.28	.0044	.0000	.12	2.2	.0414
Braintree, . .	Filter gallery, . . .	.07	6.08	.0028	.0063	1.00	.0345	.0000	.13	1.9	.0102
Bridgewater, .	Wells, ...	.35	9.30	.0024	.0040	0.40	.0060	.0000	.02	3.3	.1100

Averages of Chemical Analyses of Ground-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.			
Brookline,	Tubular wells and filter gallery.	.14	9.73	.0038	.0052	0.63	.0293	.0001	.14	4.9	.0287
Canton,	Springdale well,	.01	3.76	.0002	.0010	0.39	.0082	.0000	.03	1.3	.0108
	Well near Henry's Spring,	.13	4.96	.0004	.0024	0.44	.0202	.0000	.13	1.3	.0090
Cohasset,	Tubular wells No. 1,	.02	13.40	.0005	.0019	1.87	.0375	.0000	.02	5.7	.0155
	Tubular wells No. 2,	.01	11.93	.0002	.0023	1.67	.0900	.0000	.06	4.8	.0027
	Filter gallery,	.33	11.57	.2653	.0122	1.24	.0090	.0009	.39	5.7	.0410
Dedham,	Tap in pumping station,	.00	10.80	.0010	.0021	0.94	.1983	.0000	.03	4.5	.0090
Dracut,	Tubular wells,	.01	7.43	.0004	.0008	0.34	.0182	.0002	.01	3.6	.0106
Dracut (Collinsville),	Tubular wells,	.01	5.43	.0007	.0032	0.25	.0210	.0001	.04	2.3	.0053
Easton,	Well,	.01	4.47	.0003	.0016	0.55	.0557	.0000	.02	1.6	.0087
Edgartown,	Tubular wells,	.02	3.90	.0002	.0011	0.88	.0032	.0000	.01	0.7	.0107
Fairhaven,	Tubular wells,	.36	6.37	.0016	.0076	0.91	.0317	.0001	.41	2.1	.0148
Foxborough,	Tubular wells,	.01	4.30	.0002	.0008	0.35	.0313	.0000	.00	0.9	.0073
Framingham,	Filter gallery,	.11	9.09	.0056	.0077	0.77	.0243	.0002	.14	4.4	.0293
Grafton,	Tap in town,	.13	12.72	.0022	.0043	1.57	.2975	.0001	.10	4.6	.0437
Groton,	Well,	.00	4.80	.0004	.0010	0.16	.0047	.0000	.00	2.4	.0052
Hingham,	Wells,	.01	5.81	.0013	.0022	0.68	.0107	.0001	.04	1.7	.0072
Hopkinton,	Tubular wells,	.00	10.80	.0003	.0017	0.97	.3325	.0000	.01	4.6	.0085
Hyde Park,	Wells near Neponset River,	.13	14.42	.0151	.0041	2.16	.0694	.0002	.10	6.0	.0720
	Wells near Mother Brook,	.11	9.27	.0004	.0051	1.03	.1874	.0001	.16	3.5	.0064
Kingston,	Tubular wells,	.00	4.50	.0004	.0024	0.69	.0040	.0000	.01	1.3	.0070
Leicester,	Wells,	.11	5.70	.0008	.0036	0.25	.0600	.0001	.14	2.5	.0130
Lowell,	Boulevard wells (tubular),	.15	4.72	.0067	.0046	0.29	.0146	.0001	.13	2.0	.0562
	Low-service Reservoir,	.10	4.91	.0025	.0059	0.29	.0171	.0001	.12	2.0	.0268
Manchester,	Large wells,	.00	11.80	.0003	.0010	1.87	.1285	.0000	.01	4.3	.0108
	Tubular wells,	.00	9.10	.0003	.0015	1.38	.1600	.0000	.01	2.8	.0065
Mansfield,	Well,	.00	3.33	.0006	.0009	0.37	.0330	.0000	.01	0.9	.0023
Marblehead,	Well No. 1,	.07	25.69	.0144	.0037	4.94	.0155	.0002	.06	9.3	.2843
	Well No. 2,	.12	18.43	.0227	.0027	1.60	.0026	.0001	.06	7.8	.4633
Marshfield,	Well,	.00	12.30	.0002	.0014	3.40	.1100	.0000	.04	3.8	.0070
Medfield,	Spring,	.01	3.50	.0190	.0032	0.29	.0050	.0012	.07	1.3	.0050
Merrimac,	Tubular wells,	.01	5.50	.0002	.0013	0.47	.0478	.0000	.00	1.9	.0123
Methuen,	Tubular wells,	.20	6.56	.0012	.0070	0.34	.0115	.0000	.24	2.7	.0336
Middleborough,	Well,	.19	6.11	.0026	.0044	0.57	.0464	.0000	.13	2.3	.1209

Averages of Chemical Analyses of Ground-water Sources, etc. — Concluded.

[Part in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.			
Millbury,	Well,	.03	4.83	.0001	.0020	0.31	.0162	.0000	.03	1.8	.0055
Millis,	Spring,	.00	8.20	.0006	.0014	0.70	.2100	.0000	.00	3.1	.0020
Monson,	Well,	.00	3.53	.0001	.0008	0.12	.0100	.0000	.00	1.3	.0023
Nantucket,	Wells,	.09	6.25	.0099	.0028	1.88	.0135	.0000	.04	1.7	.0665
Natick,	Well,	.00	8.38	.0003	.0016	0.54	.0340	.0000	.01	4.4	.0032
Needham,	Well No. 1,	.00	6.62	.0002	.0014	0.74	.1367	.0000	.01	2.4	.0050
	Well No. 2,	.00	7.15	.0002	.0015	0.78	.1558	.0000	.01	2.6	.0032
	Hicks Spring,[1]	.00	4.88	.0003	.0024	0.50	.0975	.0000	.01	1.7	.0052
Newburyport,	Tap in pumping station,	.21	22.83	.0006	.0028	6.49	.0043	.0001	.04	8.0	.1583
	Tubular wells,	.19	13.40	.0006	.0012	2.69	.0018	.0001	.03	4.3	.3075
Newton,	Tubular wells and filter gallery.	.04	6.77	.0010	.0033	0.43	.0287	.0000	.08	3.0	.0063
No. Attleborough,	Old well,	.01	6.95	.0005	.0015	0.64	.0575	.0000	.01	2.8	.0090
	New well,	.00	5.40	.0002	.0014	0.33	.0040	.0000	.00	1.4	.0030
Oak Bluffs,	Springs,	.02	3.93	.0003	.0009	0.93	.0090	.0000	.00	0.7	.0087
Oxford,	Tubular wells,	.00	4.62	.0002	.0005	0.27	.0398	.0000	.00	1.6	.0038
Provincetown,	Well,	–	13.00	.0216	.0195	2.37	.0034	.0002	.84	4.2	.9750
Reading,	Filter gallery,	.45	8.75	.0109	.0097	0.92	.0047	.0001	.44	3.0	.2082
	Filtered water,	.08	9.45	.0099	.0058	0.93	.0047	.0001	.17	3.4	.0709
Scituate,	Wells,	.01	16.30	.0003	.0013	3.49	.1893	.0000	.01	5.4	.0090
Sharon,	Well,	.00	10.87	.0002	.0005	1.26	.2667	.0000	.00	4.3	.0022
Sheffield,	Spring,	.02	3.95	.0005	.0118	0.10	.0025	.0000	.23	1.9	.0070
Shirley,	Well,	.00	2.38	.0003	.0007	0.13	.0035	.0000	.00	0.3	.0042
Stoughton,	Tap at pumping station,	.22	2.98	.0007	.0061	0.34	.0037	.0000	.22	0.5	.0110
Tisbury,	Well,	.00	4.30	.0000	.0034	1.03	.0020	.0000	.01	0.5	.0035
Uxbridge,	Wells,	.00	5.11	.0003	.0009	0.50	.1157	.0000	.00	1.6	.0062
Walpole,	Tubular wells,	.00	4.40	.0006	.0010	0.35	.0292	.0000	.00	1.5	.0077
Waltham,	Well,	.16	8.33	.0041	.0031	0.71	.0291	.0000	.06	3.7	.0744
Ware,	Well,	.00	7.48	.0003	.0010	0.55	.2317	.0000	.00	2.8	.0068
Webster,	Well,	.02	3.81	.0006	.0026	0.26	.0149	.0000	.04	1.4	.0106
Wellesley,	Tubular wells,	.00	8.56	.0005	.0014	0.78	.0920	.0000	.01	3.7	.0059
	Well at Williams Spring,	.00	11.60	.0020	.0024	1.36	.3667	.0000	.04	4.6	.0120
Weston,	Well,	.15	8.53	.0008	.0068	0.50	.0306	.0000	.27	3.7	.0076
Winchendon,	Well,	.03	3.47	.0010	.0014	0.10	.0023	.0001	.03	0.5	.0660
Woburn,	Filter gallery,	.01	10.54	.0086	.0036	1.23	.0130	.0001	.07	5.3	.0028

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[1] Not used.

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

In the report for the year 1902, in the chapter entitled "Report upon the Examinations of the Outlets of Sewers and the Effect of Sewage Disposal in Massachusetts," the results of the investigation made in that year of the sources of pollution of streams in the State are presented in much detail, together with the results of analyses of the waters of these streams for a long series of years.

During the year 1907 the examinations of streams have been confined to the more important rivers.

Chemical analyses of samples of water from the following streams have been made at frequent intervals during the year: —

Assabet.
Blackstone.
Charles.
Connecticut.
French.
Hoosick.
Ipswich.
Merrimack.
Millers.
Nashua.
Neponset.
Quinepoxet.
Saugus.
Stillwater.
Sudbury.
Taunton.
Ten Mile.
Westfield.
Westfield Little.

A summary of the various analyses showing the condition of the Blackstone and Merrimack rivers at several points is appended.

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, 1887 TO 1907, INCLUSIVE.

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts in 100,000.]

MONTHS.	Color.	RESIDUE ON EVAPORATION.		Free Ammonia.	ALBUMINOID AMMONIA.			Chlorine.	NITROGEN AS —		Hardness.
		Total.	Loss on Ignition.		Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887, . .	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888, . .	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889, . .	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890, . .	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891, . .	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
" " 1892, . .	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893, . .	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894, . .	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
" " 1895, . .	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
" " 1896, . .	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
" " 1897, . .	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2
" " 1898, . .	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
" " 1899, . .	0.14	34.38	10.60	.2583	.0788	.0390	.0398	–	–	.0004	14.3
" " 1900, . .	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
" " 1901, . .	0.23	31.03	11.68	.1410	.0548	.0309	.0239	–	–	.0023	13.8
" " 1902, . .	0.10	46.15	12.47	.2453	.0728	.0274	.0454	–	–	.0010	16.5
" " 1903, . .	0.18	24.06	6.80	.2836	.0750	.0472	.0278	–	–	.0027	8.4
" " 1904, . .	0.12	44.68	17.08	.1228	.0434	.0225	.0209	–	–	.0008	14.7
" " 1905, . .	0.21	50.36	19.49	.0952	.0492	.0203	.0289	–	–	.0003	29.3
" " 1906, . .	0.11	40.07	15.25	.0688	.0421	.0189	.0232	–	.0032	.0002	20.3
" " 1907, . .	0.04	44.07	17.67	.0613	.0343	.0180	.0163	–	–	.0003	–

Blackstone River, below Sewage Precipitation Works.

June-Nov., 1887, . .	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888, . .	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889, . .	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890, . .	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
" " 1891, . .	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
" " 1892, . .	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893, . .	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894, . .	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895, . .	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
" " 1896, . .	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
" " 1897, . .	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
" " 1898, . .	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
" " 1899, . .	0.14	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108	.0068	16.1
" " 1900, . .	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
" " 1901, . .	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8
" " 1902, . .	0.15	49.62	13.38	.7296	.1284	.0736	.0548	2.97	–	.0033	12.5
" " 1903, . .	0.39	31.08	9.48	.3880	.1080	.0545	.0535	–	–	.0062	10.4
" " 1904, . .	–	50.25	13.73	.6381	.1523	.0601	.0922	–	–	.0027	16.9
" " 1905, . .	0.19	59.84	17.97	.4936	.0985	.0597	.0388	–	–	.0008	29.3
" " 1906, . .	0.19	49.69	11.42	.6330	.1818	.0580	.1238	–	.0058	.0130	15.0
" " 1907, . .	0.37	40.40	7.87	.7600	.0837	.0580	.0257	5.15	.0255	.0061	–

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River, etc. — *Concluded.*

Blackstone River, at Uxbridge.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as —		Hardness.
		Total.	Loss on Ignition.		Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887, . .	.39	–	–	.1129	.0271	–	–	0.79	.0360	–	–
“ “ 1888, . .	.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	–
“ “ 1889, . .	.32	–	–	.1133	.0296	.0192	.0104	0.66	.0333	.0009	–
“ “ 1890, . .	.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
“ “ 1891, . .	.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
“ “ 1892, . .	.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
“ “ 1893, . .	.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
“ “ 1894, . .	.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
“ “ 1895, . .	.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
“ “ 1896, . .	.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
“ “ 1897, . .	.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
“ “ 1898, . .	.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
“ “ 1899, . .	.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
“ “ 1900, . .	.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
“ “ 1901, . .	.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0
“ “ 1902, . .	.15	14.17	2.56	.3462	.0270	.0218	.0052	1.95	.0210	.0018	4.9
“ “ 1903, . .	.30	13.16	2.52	.3030	.0262	.0215	.0047	1.74	.0210	.0024	4.4
“ “ 1904, . .	.20	13.78	2.74	.2399	.0282	.0214	.0068	2.12	.0408	.0022	4.6
“ “ 1905, . .	.21	16.34	2.55	.3928	.0246	.0203	.0043	2.65	.0175	.0025	5.0
“ “ 1906, . .	.19	14.73	3.10	.2218	.0242	.0200	.0042	2.10	.0252	.0009	4.2
“ “ 1907, . .	.37	14.23	2.58	.2331	.0238	.0182	.0056	2.36	.0330	.0040	4.5

Blackstone River, at Millville.

June-Nov., 1887, . .	.31	–	–	.0468	.0220	–	–	0.51	.0210	–	–
“ “ 1888, . .	.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	–
“ “ 1889, . .	.38	–	–	.0499	.0273	.0213	.0060	0.45	.0167	.0003	–
“ “ 1890, . .	.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
“ “ 1891, . .	.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
“ “ 1892, . .	.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
“ “ 1893, . .	.23	7.43	1.73	.0677	.0119	.0087	.0032	0.77	.0385	.0011	2.6
“ “ 1894, . .	.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
“ “ 1895, . .	.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
“ “ 1896, . .	.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
“ “ 1897, . .	.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
“ “ 1898, . .	.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
“ “ 1899, . .	.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
“ “ 1900, . .	.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
“ “ 1901, . .	.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1
“ “ 1902, . .	.28	9.43	2.24	.1623	.0284	.0238	.0046	1.20	.0195	.0010	2.8
“ “ 1903, . .	.33	8.46	1.85	.1397	.0233	.0189	.0044	1.10	.0192	.0010	2.9
“ “ 1904, . .	.29	8.71	2.06	.1079	.0235	.0201	.0034	1.26	.0337	.0009	2.9
“ “ 1905, . .	.28	10.76	2.03	.1956	.0311	.0222	.0089	1.67	.0207	.0008	2.9
“ “ 1906, . .	.37	9.02	2.15	.1526	.0306	.0251	.0055	1.27	.0188	.0006	2.4
“ “ 1907, . .	.37	10.43	2.21	.1521	.0240	.0181	.0059	1.61	.0247	.0014	3.1

NOTE. — The sewage purification works of the city of Worcester were put in operation in 1890, since which time a portion of the sewage of the city has been treated. The works were enlarged in 1893, and since that time practically all of the dry-weather flow of sewage has been treated.

MERRIMACK RIVER.

Table comparing the Analyses above Lowell with those above Lawrence, 1907.

[Parts in 100,000.]

		RESIDUE ON EVAPORATION.		AMMONIA.					NITROGEN AS —		
					ALBUMINOID.						
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dis-solved.	Sus-pended.	Chlorino.	Nitrates.	Nitrites.	Hardness.
Mean of analyses above Lowell, .	.36	4.38	1.77	.0072	.0182	.0132	.0050	.24	.0045	.0002	1.1
Mean of analyses above Lawrence, .	.39	4.56	1.74	.0200	.0235	.0168	.0067	.33	.0054	.0004	1.2
Increase, ...	.03	0.18	0.03[1]	.0128	.0053	.0036	.0017	.09	.0009	.0002	0.1

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years.

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts in 100,000.]

DATE.		RESIDUE ON EVAPORATION.		AMMONIA.					NITROGEN AS —		
					ALBUMINOID.						
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dis-solved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
Increase, 1887-1889, .	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003[1]	.0000	–
Increase, 1890, . .	0.05	0.62	0.22[1]	.0016	.0023	.0017	.0006	.028	.0020[1]	.0000	0.2
Increase, 1891, . .	0.02[1]	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030[1]	.0000	0.1
Increase, 1892, . .	0.06	0.48	0.12	.0019	.0037	.0037	.0000	.039	.0013[1]	.0000	0.0
Increase, 1893, . .	0.09	0.47	0.30	.0031	.0032	.0021	.0011	.035	.0002[1]	.0001	0.0
Increase, 1894, . .	0.02	0.15	0.04	.0028	.0032	.0032	.0000	.049	.0000	.0000	0.1
Increase, 1895, . .	0.11	0.52	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896, . .	0.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2
Increase, 1897, . .	0.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1
Increase, 1898, . .	0.03	0.37	0.07	.0024	.0039	.0019	.0020	.044	.0010	.0002	0.1
Increase, 1899, . .	0.02	0.39	0.07	.0038	.0045	.0023	.0022	.059	.0004[1]	.0001	0.1
Increase, 1900, . .	0.03	0.41	0.11	.0037	.0027	.0026	.0001	.055	.0011	.0000	0.0
Increase, 1901, . .	0.03	0.27	0.03	.0032	.0044	.0023	.0021	.053	.0020	.0003	0.3
Increase, 1902, . .	0.03	0.52	0.20	.0032	.0063	.0027	.0036	.060	.0000	.0001	0.1
Increase, 1903, . .	0.04	0.56	0.18	.0043	.0065	.0045	.0020	.072	.0014	.0002	0.2
Increase, 1904, . .	0.02	0.31	0.06	.0092	.0047	.0026	.0021	.100	.0004[1]	.0001	0.1
Increase, 1905, . .	0.04	0.44	0.09	.0047	.0042	.0024	.0018	.102	.0002	.0002	0.1
Increase, 1906, . .	0.02	0.56	0.28	.0039	.0045	.0029	.0016	.100	.0004[1]	.0001	0.2
Increase, 1907, . .	0.03	0.18	0.03[1]	.0128	.0053	.0036	.0017	.094	.0009	.0002	0.1

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,434, 8,126, 5,459, 11,634, 5,886, 8,230, 9,402, 7,406, 7,389, 8,524, 9,160, 9,674, 7,410, 7,451, 8,484 and 7,123 cubic feet per second.

[1] Decrease.

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

WATER SUPPLY STATISTICS.

During the year 1907 a water supply was introduced into the town of Chelmsford (population, 4,254).

Of the 354 cities and towns in Massachusetts, all of the 33 cities and 152 of the towns are provided with public water supplies. The following table gives a classification by population of the cities and towns having and not having public water supplies: —

Population (1905).	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having Public Water Supplies.	Total Population of Places in Preceding Column.
Under 500,	-	-	36	12,513
500-999,	4	3,755	50	36,782
1,000-1,499,	14	16,949	36	44,942
1,500-1,999,	13	23,445	22	38,534
2,000-2,499,	13	28,293	15	32,174
2,500-2,999,	13	35,009	2	5,517
3,000-3,499,	8	25,943	2	6,441
3,500-3,999,	5	18,931	3	11,394
Above 4,000,	115	2,648,521	3	14,537
Totals,	185	2,800,846	169	202,834

All of the towns except Blackstone having a population in excess of 5,000 are supplied with water, and there are only 8 towns in the State having a population in excess of 3,000 which are not provided with public water supplies. These towns are as follows: —

Town.	Population in 1905.	Town.	Population in 1905.
Blackstone,	5,786	Dartmouth,	3,793
Tewksbury,	4,415	Templeton,	3,783
Barnstable,	4,336	Pepperell,	3,268
Dudley,	3,818	Sutton,	3,173

At the present time the water works are owned either by the municipality or by a fire or water supply district in all of the cities and 106 of the towns, while in 46 towns the works are owned by private companies. The following table gives a classification by population of the cities and towns which own their water works and those which are supplied with water by private companies: —

Population (1905).	Number of Places of Given Population owning Water Works.	Total Population of Places in Preceding Column.	Number of Places of Given Population supplied with Water by Private Companies.	Total Population of Places in Preceding Column.
Under 1,000,	2	1,886	2	1,869
1,000-1,999,	18	28,310	9	12,084
2,000-2,999,	13	31,614	13	31,688
3,000-3,999,	6	20,559	7	24,315
4,000-4,999,	13	57,088	5	22,410
5,000-5,999,	11	60,243	3	15,609
6,000-6,999,	12	77,889	1	6,754
7,000-7,999,	7	50,508	3	22,929
Above 8,000,	57	2,297,476	3	37,615
Totals,	139	2,625,573	46	175,273

From the totals given in the above tables it will be seen that the population of those towns supplied with water by private companies is only 6.2 per cent. of the total population in all of the cities and towns supplied with water, and that there are now only 3 towns having a population above 8,000 which are supplied by private companies. These are Hyde Park,[1] Milford and Southbridge.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped, and in several cities and towns Venturi meters are used to measure the quantity supplied. A summary of these statistics for the year 1907 is given in the following table. The estimated population given in the table is obtained by adding two-fifths of the increase in population from 1900 to 1905 to the population as determined by the census in the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated population. The quantity obtained in this manner varies somewhat from the actual consumption per person using the water, as, in many cities and towns, there is a considerable number of people who do not use the public water supply, while in some of the towns used as summer resorts the population using the water during the summer months is much greater than the population shown by the census. With a few exceptions, however, the error is not large.

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[1] The town of Hyde Park voted early in January, 1906, to take the works of the Hyde Park Water Company.

Statistics relating to the Consumption of Water in Various Cities and Towns.

City or Town.	Estimated Population. 1907.	Average Daily Consumption (Gallons). 1907.	Daily Consumption per Inhabitant (Gallons). 1907.	City or Town.	Estimated Population. 1907.	Average Daily Consumption (Gallons). 1907.	Daily Consumption per Inhabitant (Gallons). 1907.
Metropolitan water district: —				Danvers and Middleton.	10,431	925,000	89
Arlington,	10,094	940,000	93	Dedham,	7,901	868,000	110
Belmont,	4,532	331,000	73	Easton,	4,938	131,000	27
Boston,	609,175	96,423,000	158	Fairhaven,	4,502	344,000	76
Chelsea,	38,576	3,761,000	97	Fall River,	106,122	4,941,000	47
Everett,	31,021	2,555,000	82	Foxborough,	3,403	199,000	58
Lexington,	4,810	324,000	67	Framingham,	11,646	615,000	53
Malden,	39,786	1,857,000	47	Franklin,	5,335	244,000	46
Medford,	20,263	2,173,000	107	Gardner,	12,492	875,000	70
Melrose,	14,828	1,748,000	118	Gloucester,	25,967	1,351,000	52
Milton,	7,244	340,000	47	Groton,	2,333	86,000	37
Nahant,	830	135,000	163	Holliston,	2,689	33,000	12
Quincy,	29,747	2,997,000	101	Holyoke,	51,623	5,272,000	102
Revere,	13,565	1,241,000	91	Hyde Park,	15,016	1,172,000	78
Somerville,	72,324	6,548,000	91	Ipswich,	5,424	184,000	34
Stoneham,	6,386	607,000	95	Lancaster,	2,377	91,000	39
Swampscott,	5,378	475,000	88	Lawrence,	73,046	3,511,000	48
Watertown,	11,879	797,000	67	Lincoln,	1,120	187,000	167
Winthrop,	7,424	883,000	119	Lowell,	94,857	5,534,000	58
Abington and Rockland.	12,214	509,000	42	Lynn and Saugus,	87,174	6,018,000	69
Andover,	6,560	528,000	81	Manchester,	2,656	246,000	93
Attleborough,	13,249	662,000	50	Mansfield,	4,341	256,000	59
Avon,	1,965	103,000	52	Marblehead,	7,060	669,000	95
Ayer,	2,362	127,000	54	Marlborough,	14,259	599,000	42
Beverly,	15,759	1,567,000	99	Maynard,	6,879	259,000	38
Billerica,	2,870	84,000	29	Merrimac,	1,785	88,000	49
Braintree,	7,238	484,000	67	Methuen,	9,142	363,000	40
Bridgewater and East Bridgewater.	10,360	210,000	20	Middleborough,	6,888	328,000	47
Brockton,	50,886	1,811,000	36	Milford and Hopedale.	14,429	833,000	58
Brookline,	24,836	2,236,000	90	Millbury,	4,699	206,000	44
Cambridge,	99,653	10,992,000	110	Montague and Erving.	8,503	492,000	58
Canton,	4,749	244,000	51	Nantucket,	2,900	174,000	60
Clinton,	12,880	533,000	41	Natick,	9,657	578,000	60

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Estimated Population. 1907.	Average Daily Consumption (Gallons). 1907.	Daily Consumption per Inhabitant (Gallons). 1907.
Needham,	4,391	315,000	72
New Bedford,	79,130	7,436,000	94
Newburyport,	14,754	848,000	57
Newton,	38,123	2,318,000	61
North Andover,	4,762	197,000	41
North Attleborough,	8,128	317,000	39
North Brookfield,	1,829	172,000	94
Norwood,	7,231	428,000	59
Orange,	5,601	146,000	26
Peabody,	13,728	2,312,000	169
Randolph and Holbrook.	6,671	323,000	48
Reading,	5,967	165,000	28
Rockport,	4,389	286,000	65
Rutland,	1,865	90,000	48
Salem,	38,295	3,315,000	86
Scituate,	2,648	112,000	43
Sharon,	2,095	99,000	47
Shirley,	1,697	32,000	19
Stoughton,	6,166	218,000	35
Taunton,	30,939	2,144,000	69
Tisbury,	1,108	109,000	98
Wakefield,	10,659	724,000	68
Walpole,	4,175	376,000	90
Waltham,	27,402	2,272,000	83
Ware,	8,726	385,000	44
Wareham,	3,751	39,000	10
Webster,	10,504	365,000	35
Wellesley,	6,636	305,000	46
Weston,	2,194	76,000	35
Whitman,	6,667	209,000	31
Winchendon,	6,306	111,000	18
Woburn,	14,461	1,682,000	116
Worcester,	132,021	9,502,000	72

RAINFALL.

The average rainfall in Massachusetts, as deduced from long-continued observations in various parts of the State, is 45.29 inches. The average rainfall for the year 1907 in these places was 44.49 inches, making a deficiency of 0.80 of an inch. There was an excess of rainfall in May, September, November and December, and a deficiency during the remaining eight months. The greatest excess in any one month occurred in September, when the rainfall was 8.58 inches. The greatest deficiency occurred in August, when the rainfall was 1.30 inches.

Taken as a whole, the year was characterized by a very low rainfall during the first eight months, January to August inclusive, causing a drought during the summer which affected seriously many of the sources of public water supply. The drought was a short one and was terminated by the excessive rainfall of September. More than half the total rainfall for the year occurred in the last four months.

The following table gives the normal rainfall in the State for each month, as deduced from observations at various places for a long period of years, together with the average rainfall at those places for each month during 1907 and the departure from the normal: —

MONTH.	Normal Rainfall (Inches).	Rainfall 1907 (Inches).	Excess or Deficiency 1907 (Inches).	MONTH.	Normal Rainfall (Inches).	Rainfall 1907 (Inches).	Excess or Deficiency 1907 (Inches).
January, . .	3.87	3.38	—0.49	August, . .	4.17	1.30	—2.87
February, . .	3.68	2.54	—1.14	September, .	3.56	8.58	+5.02
March, . .	4.12	2.12	—2.00	October, . .	3.94	3.74	—0.20
April, . . .	3.55	3.31	—0.24	November, .	3.97	6.05	+2.08
May, . . .	3.66	3.92	+0.26	December, .	3.72	4.56	+0.84
June, . . .	3.33	3.14	—0.19				
July, . . .	3.72	1.85	—1.87	Total, . .	45.29	44.49	—0.80

FLOW OF STREAMS.

Sudbury River.

The flow of the Sudbury River during the year 1907 was less than normal. The flow during the months of January, September, October, November and December was in excess of, and during the remaining months was less than, the normal. The greatest excess occurred in November and the greatest deficiency in March. During the month of August the flow was less than the evaporation from the water surfaces of the reservoirs so that the flow is represented by a minus quantity.

In order to show the relation between the flow of the Sudbury River during each month of 1907 and the normal flow of that stream, as deduced from observations during thirty-three years, from 1875 to 1907, inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point of measurement is 75.2 square miles.

MONTH.	NORMAL FLOW.		ACTUAL FLOW FOR 1907.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January, ...	1.894	1.224	2.091	1.351	+0.197	+0.127
February, ...	2.711	1.753	0.965	0.624	—1.746	—1.129
March, ...	4.508	2.914	2.565	1.658	—1.943	—1.256
April, ...	3.219	2.081	2.487	1.607	—0.732	—0.474
May, ...	1.710	1.106	1.374	0.888	—0.336	—0.218
June, ...	0.825	0.533	1.178	0.761	+0.353	+0.228
July, ...	0.299	0.193	0.014	0.009	—0.285	—0.184
August, ...	0.418	0.270	—0.161	—0.104	—0.579	—0.374
September, . . .	0.420	0.271	0.837	0.541	+0.417	+0.270
October, ...	0.768	0.496	1.146	0.741	+0.378	+0.245
November, . . .	1.351	0.873	3.092	1.998	+1.741	+1.125
December, . . .	1.690	1.092	3.143	2.032	+1.453	+0.940
Year, ...	1.645	1.063	1.562	1.010	—0.083	—0.053

The following table gives the rainfall upon the Sudbury River watershed and the total yield of the watershed expressed in inches in depth (inches of rainfall collected) for each year of the past thirty-three years from 1875 to 1907, inclusive, together with the average for that period: —

Rainfall received and collected on the Sudbury River Watershed.

MONTH.	1875.			1876.			1877.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	2.42	0.184	7.6	1.830	1.147	62.7	3.216	1.174	36.5
February,	3.15	2.411	76.5	4.210	2.282	54.2	0.739	1.529	206.9
March,	3.74	2.862	76.5	7.430	7.911	106.5	8.357	8.586	102.7
April,	3.23	5.263	162.9	4.197	5.683	135.4	3.435	4.132	120.3
May,	3.56	2.119	59.5	2.763	2.031	73.5	3.702	2.482	67.0
June,	6.24	1.501	24.0	2.040	0.383	18.8	2.425	1.031	42.5
July,	3.57	0.573	16.0	9.134	0.326	3.6	2.951	0.360	12.2
August,	5.53	0.706	12.8	1.720	0.723	42.0	3.682	0.216	5.9
September,	3.43	0.358	10.4	4.614	0.318	6.9	0.323	0.103	31.9
October,	4.85	1.152	23.8	2.241	0.417	18.6	8.515	1.127	13.2
November,	4.83	2.248	46.5	5.764	1.878	32.6	5.803	2.447	42.2
December,	0.94	1.041	110.7	3.620	0.809	22.3	0.870	2.300	264.4
Totals and averages,	45.49	20.418	44.9	49.563	23.908	48.2	44.018	25.487	57.9

Rainfall received and collected, etc. — Continued.

MONTH.	1878.			1879.			1880.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	5.632	3.228	57.3	2.478	1.249	50.4	3.566	2.000	56.02
February,	5.973	3.972	66.5	3.562	2.756	77.4	3.980	2.982	74.92
March,	4.689	6.256	133.4	5.140	4.156	80.9	3.315	2.451	73.93
April,	5.790	2.807	48.5	4.716	5.379	114.1	3.105	2.017	64.97
May,	0.956	2.487	260.2	1.579	1.987	125.8	1.836	0.917	49.95
June,	3.884	0.873	22.5	3.789	0.713	18.8	2.138	0.303	14.16
July,	2.971	0.229	7.7	3.933	0.281	7.1	6.273	0.315	5.02
August,	6.937	0.848	12.2	6.509	0.705	10.8	4.008	0.212	5.29
September,	1.291	0.277	21.5	1.878	0.243	12.9	1.603	0.138	8.64
October,	6.417	0.921	14.3	0.809	0.126	15.6	3.740	0.181	4.85
November,	7.024	2.922	41.6	2.682	0.355	13.2	1.785	0.354	19.85
December,	6.367	5.667	89.0	4.344	0.825	19.0	2.828	0.312	11.05
Totals and averages,	57.931	30.487	52.6	41.419	18.775	45.3	38.177	12.182	31.91

Rainfall received and collected, etc. — Continued.

MONTH.	1881.			1882.			1883.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	5.558	0.740	13.31	5.951	2.213	37.19	2.810	0.597	21.25
February,	4.646	2.491	53.62	4.546	3.872	85.18	3.865	1.664	43.05
March,	5.730	7.142	124.64	2.649	5.064	191.16	1.780	2.873	161.42
April,	2.000	2.669	133.44	1.824	1.497	82.09	1.845	2.330	126.27
May,	3.511	1.721	49.03	5.066	2.304	45.48	4.185	1.673	39.96
June,	5.395	2.309	42.80	1.664	0.913	54.87	2.400	0.518	21.58
July,	2.350	0.493	20.98	1.769	0.154	8.70	2.680	0.206	7.68
August,	1.358	0.264	19.45	1.667	0.099	5.91	0.735	0.140	19.06
September,	2.617	0.340	13.01	8.741	0.529	6.05	1.520	0.157	10.36
October,	2.955	0.331	11.20	2.074	0.534	25.74	5.600	0.331	5.92
November,	4.091	0.682	16.66	1.147	0.362	31.51	1.810	0.354	19.52
December,	3.958	1.383	34.93	2.296	0.561	24.45	3.550	0.345	9.72
Totals and averages,	44.169	20.565	46.56	39.394	18.102	45.95	32.780	11.188	34.13

Rainfall received and collected, etc. — Continued.

MONTH.	1884.			1885.			1886.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	5.085	1.775	34.91	4.710	2.203	46.76	6.365	2.606	40.94
February,	6.545	4.742	72.45	3.865	2.182	56.44	6.280	7.734	123.16
March,	4.720	6.752	143.06	1.070	2.805	262.14	3.610	3.672	101.72
April,	4.405	4.925	111.82	3.605	3.133	86.91	2.225	3.361	151.06
May,	3.470	1.838	52.97	3.485	2.383	68.38	2.995	1.285	42.90
June,	3.445	0.719	20.86	2.865	0.735	25.66	1.465	0.350	23.93
July,	3.665	0.399	10.89	1.425	0.111	7.77	3.265	0.206	6.32
August,	4.650	0.458	9.85	7.185	0.429	5.97	4.100	0.168	4.09
September,	0.855	0.076	8.87	1.425	0.209	14.66	2.905	0.203	6.98
October,	2.480	0.148	5.98	5.095	0.599	11.75	3.235	0.260	8.04
November,	2.645	0.302	11.44	6.095	2.033	33.35	4.645	1.161	25.01
December,	5.170	1.650	31.91	2.720	2.094	76.99	4.975	1.819	36.56
Totals and averages,	47.135	23.784	50.46	43.545	18.916	43.44	46.065	22.825	49.55

Rainfall received and collected, etc. — Continued.

Month.	1887.			1888.			1889.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January, ...	5.200	4.619	88.82	4.150	1.878	45.26	5.370	4.963	92.42
February, ...	4.780	4.558	95.35	3.685	3.255	88.32	1.655	1.926	116.39
March, ...	4.900	5.116	104.40	6.020	5.775	95.93	2.365	2.388	100.95
April, ...	4.265	4.522	106.03	2.425	4.566	188.30	3.410	2.434	71.37
May, ...	1.165	1.799	154.46	4.825	2.912	60.35	2.945	1.569	53.27
June, ...	2.650	0.714	26.93	2.535	0.728	28.70	2.800	1.128	40.27
July, ...	3.760	0.204	5.45	1.405	0.209	14.90	8.940	1.130	12.64
August, ...	5.280	0.382	7.24	6.225	0.677	10.87	4.175	2.554	61.18
September, ...	1.320	0.191	14.52	8.585	1.994	23.22	4.605	1.422	30.87
October, ...	2.835	0.339	11.96	4.990	3.566	71.45	4.255	2.194	51.57
November, ...	2.670	0.636	23.83	7.225	4.761	65.90	6.290	3.351	53.27
December, ...	3.880	1.147	29.58	5.395	5.428	100.60	3.140	3.997	127.30
Totals and averages,	42.705	24.227	56.73	57.465	35.749	62.21	40.950	29.056	58.17

Rainfall received and collected, etc. — Continued.

Month.	1890.			1891.			1892.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January, ...	2.530	2.237	88.43	7.020	5.383	76.69	5.850	3.335	57.01
February, ...	3.505	2.464	70.29	5.235	5.616	107.28	3.140	1.574	50.13
March, ...	7.735	6.498	84.01	6.475	7.944	122.69	4.060	3.488	85.90
April, ...	2.645	3.236	122.35	3.905	4.138	105.97	0.830	1.504	181.15
May, ...	5.210	2.437	46.78	2.010	1.039	51.70	5.585	2.245	40.20
June, ...	2.030	0.980	48.27	3.770	0.714	18.92	2.760	0.739	26.76
July, ...	2.460	0.192	7.78	3.395	0.266	7.83	4.230	0.382	9.03
August, ...	3.865	0.235	6.08	4.725	0.290	6.15	4.440	0.500	11.26
September, ...	6.000	0.790	13.16	2.380	0.350	14.71	2.840	0.396	13.94
October, ...	10.510	4.053	38.56	3.830	0.375	9.78	1.170	0.224	19.18
November, ...	1.200	2.097	174.72	3.090	0.526	17.03	5.800	1.204	20.75
December, ...	5.310	1.779	33.49	3.685	0.971	26.34	1.125	0.865	76.89
Totals and averages,	53.000	26.998	50.94	49.520	27.612	55.76	41.830	16.456	39.34

Rainfall received and collected, etc. — Continued.

Month.	1893.			1894.			1895.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	2.925	0.773	26.44	4.090	1.236	30.22	4.060	1.844	45.4
February,	8.195	2.485	30.32	3.910	1.596	40.82	1.395	0.871	62.5
March,	3.670	5.789	157.74	1.435	3.992	278.19	2.980	4.299	144.2
April,	3.605	3.668	101.75	3.415	2.832	82.93	5.250	4.341	82.7
May,	6.610	5.143	77.81	4.235	1.498	35.37	2.020	1.134	56.1
June,	2.380	0.759	31.88	1.155	0.723	62.60	2.770	0.301	10.8
July,	2.570	0.282	10.96	3.255	0.287	8.82	5.040	0.411	8.2
August,	5.415	0.322	5.95	2.030	0.373	18.37	4.150	0.409	9.9
September,	1.735	0.187	10.75	2.635	0.258	9.79	2.300	0.153	6.7
October,	4.065	0.395	9.72	5.345	0.668	12.50	10.680	2.460	23.0
November,	2.195	0.550	25.07	3.425	1.442	42.10	6.625	4.794	72.4
December,	4.860	1.421	29.23	4.810	1.277	26.55	3.350	3.179	94.9
Totals and averages,	48.225	21.774	45.15	39.740	16.182	40.72	50.620	24.196	47.8

Rainfall received and collected, etc. — Continued.

Month.	1896.			1897.			1898.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	2.390	1.933	80.88	4.005	1.507	37.63	6.83	2.922	42.78
February,	7.180	4.466	62.20	2.910	1.718	59.04	4.49	4.869	108.44
March,	5.235	6.841	130.68	3.660	4.575	125.00	2.40	4.645	193.54
April,	1.570	2.579	164.27	2.820	2.615	92.73	4.66	3.158	67.77
May,	2.575	0.641	24.89	4.370	1.632	37.35	3.22	2.222	69.01
June,	3.220	0.689	21.40	4.455	1.661	37.28	2.48	0.915	36.90
July,	2.510	0.170	6.77	5.445	1.174	21.56	4.09	0.411	10.05
August,	2.395	0.102	4.26	3.510	1.053	30.00	8.17	1.974	24.16
September,	7.720	0.669	8.67	2.935	0.315	10.73	2.62	0.637	24.31
October,	3.765	1.055	28.02	0.470	0.168	35.74	6.71	2.069	30.83
November,	3.020	1.137	37.65	6.405	1.570	24.51	6.93	3.429	49.48
December,	2.125	1.171	55.11	5.205	2.827	54.31	3.28	3.208	97.80
Totals and averages,	43.705	21.453	49.09	46.190	20.815	45.06	55.88	30.459	54.51

Rainfall received and collected, etc. — Continued.

Month.	1899.			1900.			1901.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	4.18	4.082	97.66	4.96	1.417	28.6	1.82	0.779	42.8
February,	4.91	2.224	45.32	9.14	6.123	67.0	1.52	0.483	31.8
March,	7.01	7.501	107.00	6.35	6.518	102.6	6.57	4.912	74.8
April,	1.90	4.351	229.00	2.58	2.330	90.3	8.60	7.257	84.4
May,	1.45	0.911	62.83	4.32	2.341	54.2	7.23	5.269	72.9
June,	2.51	0.114	4.54	2.99	0.545	18.2	1.38	1.299	94.1
July,	3.22	0.035	1.09	2.42	—0.032	—1.3	5.71	0.545	9.5
August,	1.43	—0.063	—4.41	2.26	—0.060	—2.7	4.57	0.756	16.5
September,	3.95	0.162	4.10	3.36	0.112	3.3	3.30	0.527	16.0
October,	2.69	0.206	7.66	3.83	0.331	8.7	2.82	0.734	26.0
November,	2.18	0.525	24.08	5.70	1.144	20.1	2.90	0.819	28.2
December,	1.78	0.392	22.02	2.74	1.955	71.4	9.69	4.808	49.6
Totals and averages,	37.21	20.441	54.93	50.65	22.724	44.9	56.11	28.188	50.2

Rainfall received and collected, etc. — Continued.

Month.	1902.			1903.			1904.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	2.52	3.145	124.8	3.80	3.096	81.5	4.87	0.851	17.5
February,	6.18	2.697	43.6	3.95	3.672	93.0	3.00	1.472	49.1
March,	5.34	7.491	140.3	6.63	6.161	92.9	2.72	5.349	196.7
April,	4.13	3.254	78.8	2.99	3.903	130.5	8.87	5.685	64.1
May,	1.86	1.325	71.2	0.93	0.625	67.2	2.65	3.112	117.4
June,	2.89	0.523	18.1	9.25	3.431	37.1	2.80	0.723	25.8
July,	2.94	0.117	4.0	2.77	0.794	28.7	1.96	0.111	5.7
August,	3.40	0.240	7.1	3.67	0.547	14.9	3.86	0.303	7.8
September,	4.54	0.308	6.8	1.75	0.225	12.9	5.80	0.685	11.8
October,	4.44	0.902	20.3	4.72	0.877	18.6	1.64	0.348	21.2
November,	1.45	0.767	52.9	1.56	0.626	40.1	1.73	0.499	28.8
December,	6.38	3.173	49.7	3.14	1.038	33.1	2.92	0.481	16.5
Totals and averages,	46.07	23.942	52.0	45.16	24.995	55.3	42.82	19.619	45.8

Rainfall received and collected, etc. — Continued.

MONTH.	1905.			1906.			1907.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	5.26	2.516	47.8	2.47	2.012	81.5	3.28	2.411	73.5
February,	2.20	0.531	24.1	2.92	1.676	57.4	2.17	1.005	46.3
March,	3.15	4.456	141.5	6.32	4.297	68.0	1.91	2.958	154.9
April,	2.72	2.837	104.3	2.88	3.364	116.8	3.41	2.774	81.3
May,	1.31	0.530	40.5	5.66	1.890	33.4	3.63	1.584	43.6
June,	5.00	0.806	16.1	3.91	1.220	31.2	3.53	1.314	37.2
July,	5.47	0.316	5.8	3.42	0.709	20.7	1.86	0.015	0.8
August,	2.70	0.204	7.6	3.02	0.321	10.6	1.07	—0.186	—17.4
September,	6.88	2.152	31.3	3.30	0.034	1.0	8.76	0.934	10.7
October,	1.54	0.282	18.3	3.40	0.538	15.8	4.17	1.321	31.7
November,	2.07	0.481	23.2	2.69	0.834	31.0	6.12	3.450	56.4
December,	4.01	1.583	39.5	4.49	1.175	26.2	4.47	3.624	81.1
Totals and averages,	42.31	16.694	39.5	44.48	18.070	40.6	44.38	21.204	47.8

Rainfall received and collected, etc. — Concluded.

MONTH.	MEAN FOR THIRTY-THREE YEARS, 1875-1907.		
	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.	
January,	4.16	2.183	52.5
February,	4.17	2.845	68.2
March,	4.52	5.198	115.0
April,	3.55	3.592	101.2
May,	3.36	1.972	58.7
June,	3.18	0.920	28.9
July,	3.66	0.345	9.4
August,	3.89	0.483	12.4
September,	3.59	0.468	13.0
October,	4.12	0.886	21.5
November,	3.93	1.507	38.4
December,	3.86	1.949	50.5
Totals and averages,	45.99	22.348	48.6

The Sudbury River records are particularly valuable as a basis for estimating the yield of other watersheds in Massachusetts, both on account of the accuracy with which the measurements have been made and the absence of abnormal conditions which would unfavorably affect the results.

The following table gives the records of the yield of this watershed for each year of the past thirty-three years, the flow from the watershed being expressed in gallons per day per square mile of watershed, in order to render the table more convenient for use in estimating the probable yield of watersheds used as sources of water supply: —

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000	415,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000	4,004,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000	1,546,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000	965,000
June,	870,000	222,000	597,000	506,000	413,000	176,000	1,338,000
July,	321,000	183,000	202,000	128,000	158,000	177,000	276,000
August,	396,000	405,000	121,000	475,000	395,000	119,000	148,000
September,	207,000	184,000	60,000	160,000	141,000	80,000	197,000
October,	646,000	234,000	632,000	516,000	71,000	101,000	186,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000	775,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000

MONTH.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
January,	1,241,000	335,000	995,000	1,235,000	1,461,000	2,589,000	1,053,000
February,	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000	2,829,000	1,951,000
March,	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000	3,237,000
April,	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000	2,645,000
May,	1,292,000	938,000	1,030,000	1,336,000	720,000	1,009,000	1,632,000
June,	529,000	300,000	417,000	426,000	203,000	414,000	422,000
July,	86,000	115,000	224,000	62,000	115,000	114,000	117,000
August,	55,000	78,000	257,000	240,000	94,000	214,000	380,000
September,	306,000	91,000	44,000	121,000	118,000	111,000	1,155,000
October,	299,000	186,000	83,000	336,000	146,000	190,000	1,999,000
November,	210,000	205,000	175,000	1,178,000	673,000	368,000	2,758,000
December,	314,000	193,000	925,000	1,174,000	1,020,000	643,000	3,043,000
Average for whole year,	862,000	533,000	1,129,000	901,000	1,087,000	1,154,000	1,697,000
Average for driest six months,	211,000	145,000	200,000	391,000	223,000	234,000	953,000

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[1] The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile— Continued.

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
January,	2,782,000	1,254,000	3,018,000	1,870,000	433,000	693,000	1,034,000
February,	1,195,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000
March,	1,339,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000
April,	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000
May,	880,000	1,366,000	582,000	1,259,000	2,883,000	840,000	636,000
June,	653,000	568,000	414,000	428,000	440,000	419,000	174,000
July,	633,000	108,000	149,000	214,000	158,000	161,000	231,000
August,	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000
September,	824,000	458,000	203,000	229,000	108,000	150,000	89,000
October,	1,230,000	2,272,000	210,000	126,000	221,000	374,000	1,379,000
November,	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000
December,	2,241,000	997,000	544,000	485,000	797,000	716,000	1,782,000
Average for whole year,	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000
Average for driest six months,	944,000	747,000	239,000	327,000	237,000	356,000	460,000

MONTH.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January,	1,084,000	845,000	1,638,000	2,288,000	794,000	437,000	1,763,000
February,	2,676,000	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000
March,	3,835,000	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000
April,	1,494,000	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000
May,	360,000	915,000	1,246,000	511,000	1,312,000	2,954,000	743,000
June,	399,000	962,000	530,000	66,000	316,000	753,000	303,000
July,	95,000	658,000	231,000	19,000	—18,000	306,000	66,000
August,	57,000	591,000	1,107,000	—35,000	—34,000	424,000	135,000
September,	388,000	182,000	369,000	94,000	65,000	305,000	178,000
October,	592,000	94,000	1,160,000	115,000	186,000	412,000	506,000
November,	659,000	909,000	1,986,000	304,000	663,000	474,000	444,000
December,	657,000	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,779,000
Average for whole year,	1,019,000	991,000	1,450,000	973,000	1,082,000	1,342,000	1,140,000
Average for driest six months,	314,000	564,000	777,000	93,000	194,000	445,000	271,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Concluded.

MONTH.	1903.	1904.	1905.	1906.	1907.	Mean for 33 Years, 1875-1907.
January,	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,224,000
February,	2,279,000	882,000	330,000	1,041,000	624,000	1,753,000
March,	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,914,000
April,	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000	2,081,000
May,	351,000	1,745,000	297,000	1,059,000	888,000	1,106,000
June,	1,987,000	419,000	467,000	707,000	761,000	533,000
July,	445,000	62,000	177,000	398,000	9,000	193,000
August,	307,000	170,000	114,000	180,000	—104,000	270,000
September,	130,000	397,000	1,246,000	19,000	541,000	271,000
October,	492,000	191,000	158,000	301,000	741,000	496,000
November,	363,000	289,000	279,000	483,000	1,998,000	873,000
December,	582,000	269,000	887,000	659,000	2,032,000	1,092,000
Average for whole year,	1,190,000	931,000	795,000	860,000	1,010,000	1,063,000
Average for driest six months,	386,000	228,000	403,000	341,000	471,000	438,000

Nashua River.

The flow of the south branch of the Nashua River during the year 1907 was less than normal. The flow was in excess of the normal during the months of January, September, October, November and December, and below the normal during the remaining months. The greatest excess occurred in November and the greatest deficiency in March. In order to show the relation between the flow of the Nashua River during each month of the year 1907 and the normal flow of that stream as deduced from observations during eleven years, from 1897 to 1907, inclusive, the following table has been prepared. The area of the watershed of the Nashua River above the point of measurement is 119 square miles.

MONTH.	NORMAL FLOW.		ACTUAL FLOW FOR 1907.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.860	1.202	2.257	1.458	+0.397	+0.256
February,	2.065	1.335	1.070	0.692	—0.995	—0.643
March,	4.507	2.913	2.626	1.697	—1.881	—1.216
April,	3.676	2.376	2.221	1.436	—1.455	—0.940
May,	1.908	1.233	1.494	0.965	—0.414	—0.268
June,	1.397	0.903	1.196	0.773	—0.101	—0.130
July,	0.797	0.515	0.518	0.335	—0.279	—0.180
August,	0.744	0.481	0.135	0.087	—0.609	—0.394
September,	0.728	0.471	1.254	0.810	+0.526	+0.339
October,	1.011	0.654	2.138	1.382	+1.127	+0.728
November,	1.493	0.965	3.930	2.540	+2.437	+1.575
December,	2.323	1.501	3.035	1.961	+0.712	+0.460
Year,	1.875	1.212	1.825	1.180	—0.050	—0.032

The following table gives the rainfall upon the Nashua River watershed and the total yield of the watershed expressed in inches in depth (inches of rainfall collected, for each of the eleven years from 1897 to 1907, inclusive, together with the average for that period: —

Rainfall received and collected on the Nashua River Watershed.

MONTH.	1897.			1898.			1899.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	3.46	1.420	41.0	6.65	2.787	41.9	2.93	3.731	127.3
February,	2.86	1.500	52.4	3.30	2.635	79.8	5.12	1.757	34.3
March,	4.01	4.922	122.7	2.27	5.509	242.7	6.75	4.952	73.4
April,	2.32	2.818	121.5	4.43	3.500	79.0	1.94	5.829	300.5
May,	5.06	2.075	41.0	3.38	2.480	73.4	1.33	1.538	115.6
June,	5.11	2.039	39.9	3.11	1.429	46.0	5.51	0.969	17.6
July,	8.65	2.572	29.7	3.01	0.593	19.7	3.82	0.631	16.5
August,	3.47	1.599	46.1	10.61	2.363	22.3	3.20	0.421	13.2
September,	1.93	0.656	34.0	3.15	1.166	37.0	4.11	0.431	10.5
October,	0.94	0.434	46.2	7.21	2.691	37.3	2.72	0.437	16.1
November,	7.62	2.214	29.1	6.81	3.746	55.0	1.94	0.742	38.2
December,	6.41	4.059	63.3	3.99	3.676	92.1	2.03	0.640	31.5
Totals and averages,	51.84	26.308	50.7	57.92	32.575	56.2	41.40	22.078	53.3

Rainfall received and collected, etc. — Continued.

MONTH.	1900.			1901.			1902.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January,	4.56	1.420	31.1	1.75	0.926	52.9	2.72	2.990	109.9
February,	8.69	6.532	75.2	1.13	0.574	50.8	4.91	2.258	46.0
March,	6.19	6.639	107.3	5.82	4.849	83.3	5.27	7.120	135.1
April,	2.76	2.727	98.8	9.64	8.605	89.3	4.36	3.728	85.5
May,	4.34	2.467	56.8	7.02	4.867	69.3	2.24	1.839	82.1
June,	3.59	0.998	27.8	1.51	1.701	112.6	2.51	0.708	28.2
July,	3.20	0.388	12.1	5.66	0.851	15.0	3.87	0.521	13.5
August,	3.18	0.351	11.0	4.58	0.913	19.9	3.95	0.529	13.4
September,	3.46	0.220	6.4	3.10	0.552	17.8	4.26	0.416	9.8
October,	2.90	0.504	17.4	3.70	1.154	31.2	6.36	1.696	26.7
November,	6.44	1.510	23.4	2.43	0.892	36.7	0.93	1.095	117.7
December,	3.15	2.800	88.9	9.36	5.766	61.6	7.20	3.295	45.8
Totals and averages,	52.46	26.556	50.6	55.70	31.650	56.8	48.58	26.195	53.9

Rainfall received and collected, etc. — Continued.

MONTH.	1903.			1904.			1905.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January, ...	2.85	2.256	79.2	4.02	1.176	29.3	6.10	2.258	37.0
February, . . .	4.42	3.436	77.7	2.66	1.547	58.2	1.72	0.729	42.4
March, ...	6.58	6.107	92.8	3.40	5.361	157.7	3.95	5.358	135.7
April, ...	3.10	3.864	124.6	7.45	5.149	69.1	2.60	2.792	107.4
May, ...	1.24	1.015	81.9	2.99	2.671	89.3	0.83	0.794	95.7
June, ...	10.37	3.678	35.5	3.44	1.315	38.2	4.88	0.935	19.2
July, ...	3.43	1.114	32.5	3.84	0.886	23.1	5.39	0.651	12.1
August, ...	3.88	0.846	21.8	3.68	0.633	17.2	3.09	0.573	18.5
September, . . .	2.93	0.647	22.1	5.30	0.853	16.1	6.90	2.119	30.7
October, ...	4.43	1.228	27.7	1.78	0.620	34.8	1.81	0.654	36.1
November, . . .	2.36	1.095	46.4	1.62	0.591	36.5	2.52	0.763	30.3
December, . . .	3.99	1.702	42.7	2.88	0.784	27.2	3.79	1.816	48.0
Totals and averages,	49.58	26.988	54.4	43.06	21.586	50.1	43.58	19.442	44.6

Rainfall received and collected, etc. — Concluded.

MONTH.	1906.			1907.			MEAN FOR 11 YEARS, 1897-1907.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
	Inches.	Inches.		Inches.	Inches.		Inches.	Inches.	
January, ...	2.59	2.018	77.9	2.84	2.601	91.6	3.68	2.144	58.3
February, . . .	2.74	1.654	60.4	2.32	1.115	48.0	3.62	2.158	59.5
March, ...	5.17	3.317	64.2	1.82	3.028	166.3	4.66	5.197	111.5
April, ...	3.12	3.640	116.7	2.65	2.479	93.5	4.03	4.103	101.8
May, ...	6.58	2.734	41.5	2.96	1.722	58.2	3.45	2.200	63.8
June, ...	5.95	2.043	34.3	3.54	1.334	37.7	4.50	1.559	34.6
July, ...	5.52	1.299	23.5	3.03	0.597	19.7	4.49	0.918	20.4
August, ...	4.34	1.055	24.3	1.26	0.155	12.3	4.11	0.858	20.9
September, . . .	2.61	0.478	18.3	9.50	1.399	14.7	4.30	0.812	18.9
October, ...	3.95	0.945	24.0	5.68	2.465	43.4	3.77	1.166	30.9
November, . . .	2.25	1.294	57.5	5.74	4.384	76.4	3.70	1.666	45.0
December, . . .	4.26	1.417	33.3	4.40	3.499	79.5	4.68	2.678	57.2
Totals and averages,	49.08	21.894	44.6	45.74	24.778	54.2	48.99	25.459	52.0

The following table gives the records of the yield of this watershed for each year of the past eleven years, the flow being expressed in gallons per day per square mile of watershed: —

Yield of the Nashua River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000
September,	380,000	676,000	250,000	127,000	320,000	241,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000
Average for whole year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000
Average for driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000

MONTH.	1903.	1904.	1905.	1906.	1907.	Mean for 11 Years, 1897–1907.
January,	1,265,000	659,000	1,266,000	1,132,000	1,458,000	1,202,000
February,	2,133,000	927,000	452,000	1,027,000	692,000	1,335,000
March,	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000	2,913,000
April,	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	2,376,000
May,	569,000	1,498,000	445,000	1,533,000	965,000	1,233,000
June,	2,131,000	762,000	542,000	1,184,000	773,000	903,000
July,	624,000	497,000	365,000	728,000	335,000	515,000
August,	474,000	355,000	321,000	591,000	87,000	481,000
September,	375,000	494,000	1,228,000	277,000	810,000	471,000
October,	689,000	347,000	367,000	530,000	1,382,000	654,000
November,	634,000	343,000	442,000	749,000	2,540,000	965,000
December,	954,000	440,000	1,018,000	794,000	1,961,000	1,501,000
Average for whole year,	1,285,000	1,025,000	926,000	1,043,000	1,180,000	1,212,000
Average for driest six months,	626,000	413,000	541,000	613,000	725,000	663,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897–1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906 and to 6 per cent. in 1907.

Sudbury, Nashua and Merrimack Rivers.

The following table shows the weekly fluctuation during 1907 in the flow of three streams which were carefully measured, namely, the Sudbury River at Framingham, the south branch of the Nashua River above Cilnton, and the Merrimack River at Lowell. The flow of these streams, particularly that of the Sudbury and of the south branch of the Nashua, serves to indicate the flow of other streams in eastern Massachusetts. The flow of the Merrimack River is affected to some extent by the diversion of water from two of its tributaries for the water supply of the metropolitan district. The quantity diverted in 1907 amounted to about 196 cubic feet per second, which would reduce the figures given for the flow per square mile of watershed about 0.042 of a cubic foot per second. The watershed of the Sudbury River is 75.2 square miles, of the Nashua 119 square miles and of the Merrimack 4,664 square miles.

WEEK ENDING SUNDAY.	FLOW IN CUBIC FEET PER SECOND PER SQUARE MILE OF WATERSHED.			WEEK ENDING SUNDAY.	FLOW IN CUBIC FEET PER SECOND PER SQUARE MILE OF WATERSHED.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
Jan. 6, . .	5.249	4.707	1.880	July 7, . .	0.260	0.480	0.852
13, . .	2.071	2.243	1.962	14, . .	0.118	0.787	0.744
20, . .	1.414	1.761	0.909	21, . .	0.013	0.618	0.677
27, . .	1.563	1.597	0.939	28, . .	—0.094	0.275	0.583
Feb. 3, . .	1.143	1.248	0.765	Aug. 4, . .	—0.114	0.332	0.558
10, . .	1.106	1.408	0.682	11, . .	—0.136	0.139	0.526
17, . .	0.964	1.007	0.652	18, . .	—0.214	0.017	0.453
24, . .	0.872	0.856	0.628	25, . .	—0.158	0.170	0.361
Mar. 3, . .	0.975	0.839	0.582	Sept. 1, . .	—0.176	0.096	0.267
10, . .	0.516	0.847	0.575	8, . .	0.561	0.689	0.438
17, . .	2.183	2.340	0.741	15, . .	0.399	0.575	0.579
24, . .	5.090	4.470	2.378	22, . .	—0.170	0.382	0.498
31, . .	2.764	3.566	3.532	29, . .	1.847	3.164	0.824
Apr. 7, . .	1.930	2.010	3.730	Oct. 6, . .	2.087	1.726	1.868
14, . .	4.497	2.714	2.345	13, . .	1.790	3.799	1.450
21, . .	1.890	2.268	2.430	20, . .	0.307	1.113	0.885
28, . .	1.769	2.039	2.657	27, . .	0.602	1.160	0.689
May 5, . .	1.344	1.629	3.009	Nov. 3, . .	2.316	4.489	2.711
12, . .	1.600	1.626	1.984	10, . .	4.039	6.740	4.926
19, . .	1.742	1.540	1.988	17, . .	2.112	2.640	2.688
26, . .	0.838	1.049	1.604	24, . .	1.853	2.312	1.630
June 2, . .	1.467	1.758	1.272	Dec. 1, . .	4.520	3.095	1.796
9, . .	2.698	2.037	1.915	8, . .	1.595	1.654	1.177
16, . .	1.172	0.936	1.300	15, . .	4.093	3.982	2.735
23, . .	0.393	0.752	0.755	22, . .	1.862	1.844	1.875
30, . .	0.392	0.907	0.665	29, . .	4.545	4.239	2.538

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1907.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.[1]

By H. W. CLARK, *Chemist of the Board.*

The following report summarizes the results of the studies upon the purification of sewage and water during the year ended Nov. 30, 1907. The sand filters, first put into operation twenty years ago, were operated during the last six months of 1907 with sewage of about the same strength as that applied to them during their first year of operation, in order to compare as fairly as possible the results given by them when new and after many years of service. Studies of contact filters were continued, and also studies of sprinkling filters of different depths, to show clearly the relative purification that can be obtained by the operation of such filters when sewage of the character of that at Lawrence is applied to them. Sprinkling filters have been operated at the station for the past nine years, and filters similar to the modern sprinkling filter were operated there fifteen years ago. Certain of the sprinkling filters have been in operation for eight years, the results obtained, of course, becoming more valuable the longer the period of service of the filter, as these results covering a considerable period give data in regard to continued efficiency, degree of clogging with period of service, etc. Data are given showing the per cent. of the applied matter stored in these filters. Much work was done during the year in studying methods of distributing sewage upon sprinkling filters, and the results of this study are summarized. Results are also given showing the degree of purification accomplished by the refiltration of trickling filter effluents and the rates that can be maintained both by means of intermittent sand and mechanical filters. Studies in regard to the purification of mill wastes were continued, and methods of analysis and for the determination of the keeping quality or stability of the effluents of coarse filters operated at high rates were investigated.

In water filtration special attention was paid to the operation of various combinations of filters for the purpose of studying double filtration, to the filtration of water of varying degrees of pollution and to the use of coagulants in the filtration of polluted water. In studying double filtration some of the filters were operated at very high rates, one primary filter, for instance, at a rate of 100,000,000 gallons per acre daily. Investigations were made of the relative economy of removing surface clogging by scraping the filter surface or by washing the sand in place. The work of the Lawrence city filter which purifies the drinking water supply of the city of Lawrence was carefully followed during the year, and after November 5, the work of the filter constructed by the city during 1906–07 and put into operation on that date. Much work was also done in regard to the rate of flow through filters when new and after a period of service; but as these studies are being continued, they are not summarized in this report.

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[1] The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with the writer in direct charge. Mr. Stephen DeM. Gage and Mr. George O. Adams, the principal assistants of the writer at the station, have aided in the preparation of this report. A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the purification of sewage and water (1890). A similar account of the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports.

Analysis of Sewage.

The sewage used at the station is pumped through a 2½-inch pipe about 4,400 feet long. The following tables present the results of the usual analyses of the various representative samples of sewage collected during the year. "Lawrence Street sewage" is the average of samples collected weekly from the sewer from which the sewage is pumped; "regular sewage" is the average of samples collected at the experiment station on at least four days of each week; "settled sewage" is the supernatant sewage after the sedimentation of regular sewage in large tanks placed above the filter house, and is applied to certain of the filters, as will be noted later; "sewage applied to Filters Nos. 1, 6 and 9A" is the average of samples collected from all sewage applied to these filters. The other tables of sewage analyses represent the sewage applied to the filters mentioned in the tables.

Lawrence Street Sewage.

[Parts per 100,000.]

Date.	Temperature (Deg. F.).	Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Free.	Albuminoid.		Total.	In Solution.		Nitrates.	Nitrites.		
			Total.	In Solution.							
1906.											
December, . .	48	2.10	0.94	.50	2.87	1.68	9.38	.10	.0050	11.10	600,000
1907.											
January, . . .	51	2.80	1.15	.71	3.92	2.81	10.85	.10	.0085	12.99	1,005,000
February, . .	48	2.75	1.08	.63	3.37	2.35	15.50	.10	.0045	11.35	595,000
March, . . .	47	1.99	1.02	.51	3.19	2.25	10.38	.08	.0095	13.67	505,000
April, . . .	54	2.33	1.19	.65	3.44	2.38	12.23	.11	.0090	15.34	702,500
May, . . .	58	2.31	0.99	.55	2.94	1.82	12.52	.11	.0140	10.34	1,164,000
June, . . .	66	2.43	0.97	.50	2.93	1.69	19.90	.11	.0120	13.09	1,330,000
July, . . .	68	2.78	0.88	.58	2.54	2.12	21.15	.05	.0100	8.09	4,922,500
August, . . .	71	2.70	0.93	.54	2.76	1.53	18.90	.05	.0104	11.29	1,016,000
September, . .	66	2.27	0.75	.50	2.47	1.53	12.00	.06	.0133	10.45	390,000
October, . . .	64	2.64	0.92	.54	2.74	1.73	12.13	.09	.0150	10.81	732,500
November, . .	59	2.57	0.86	.49	3.37	2.31	10.70	.11	.0120	13.05	1,246,700
Average, . .	58	2.47	0.97	.56	3.05	2.02	13.80	.09	.0103	11.80	1,184,100

Regular Sewage.

[Parts per 100,000.]

Date.	Temperature (Deg. F.).	Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Albuminoid.						
		Free.	Total.	In Solution.	Total.	In Solution.			
1906.									
December,	39	5.30	1.10	.52	1.92	.85	12.36	8.24	864,000
1907.									
January,	38	4.97	1.08	.50	1.90	.86	15.02	8.54	686,300
February,	39	5.17	1.12	.47	2.02	.81	14.16	7.93	995,300
March,	40	5.38	1.11	.48	2.01	.85	11.40	9.93	971,200
April,	45	5.22	1.08	.45	1.89	.72	15.36	10.21	1,010,600
May,	55	4.74	0.86	.44	1.54	.75	16.70	6.83	1,078,100
June,	61	4.81	0.76	.35	1.39	.61	18.46	6.13	752,100
July,	70	4.20	0.55	.29	0.99	.49	19.63	4.30	1,162,700
August,	70	4.35	0.59	.33	1.25	.57	18.56	5.18	888,200
September,	66	3.30	0.52	.29	1.00	.51	15.76	5.57	549,300
October,	55	4.50	0.70	.35	1.29	.61	15.12	6.01	719,500
November,	49	5.01	0.70	.31	1.44	.61	12.53	5.98	1,240,000
Average,	52	4.75	0.85	.40	1.55	.69	15.42	7.07	909,800

Settled Sewage.[1]

1906.									
December,	55	5.27	0.77	.42	1.40	.75	12.45	5.74	1,317,900
1907.									
January,	55	5.37	0.75	.41	1.26	.70	13.80	5.94	913,700
February,	52	5.37	0.73	.40	1.27	.71	12.93	5.28	738,700
March,	53	5.47	0.71	.40	1.24	.68	11.51	6.03	616,500
April,	53	5.22	0.67	.36	1.12	.60	14.22	6.23	611,900
May,	57	4.90	0.61	.33	1.02	.55	16.93	4.78	386,300
June,	64	4.65	0.50	.27	0.82	.45	18.67	4.04	334,000
July,	70	4.36	0.36	.23	0.62	.38	19.20	2.76	466,200
August,	69	4.34	0.40	.26	0.75	.45	17.28	3.32	596,900
September,	64	3.83	0.41	.24	0.73	.42	14.86	3.98	390,700
October,	51	5.05	0.54	.33	0.92	.55	14.59	4.31	502,200
November,	51	5.25	0.51	.32	0.97	.57	11.32	4.02	1,126,700
Average,	58	4.92	0.58	.33	1.01	.57	14.81	4.70	666,800

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[1] Applied to Filters Nos. 176, 221, 135, 136, 233, 235, 247 and 248.

Solids in Regular Sewage.

[Parts per 100,000.]

	UNFILTERED.			FILTERED.			IN SUSPENSION.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
Average, . .	81.8	32.9	48.9	58.0	16.3	41.7	23.8	16.6	7.2

Solids in Settled Sewage.

Average, . .	65.3	22.5	42.8	54.6	14.8	39.8	10.7	7.7	3.0

Sewage applied to Filters Nos. 1, 6 and 9 A.

[Parts per 100,000.]

	AMMONIA.		Kjeldahl Nitrogen.	Chlorine.	Oxygen Consumed.
	Free.	Total Albuminoid.			
Dec. 1, 1906, to May 31, 1907, inclusive,	5.82	1.12	1.99	13.84	8.16
June 1 to November 30, inclusive, .	2.44	0.39	0.72	8.41	3.24

Sewage applied to Filters Nos. 2, 4, 5C and 10, from June 1 to November 30, Inclusive.

[Parts per 100,000.]

	AMMONIA.		Kjeldahl Nitrogen.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Total Albuminoid.				
Average, ...	2.31	.39	.73	7.80	3.13	731,800

Sewage applied to Filter No. 306.

Average, ...	1.88	.44	.79	5.17	3.42	–

Operation of Septic Tanks.

During the year Septic Tank A and Septic Tank F were continued in operation. Septic Tank A, started in 1897, has always been operated with regular sewage. During 1907 the sewage was passed through the tank at such a rate that it received thirty-six hours' storage. Septic Tank F, first put into operation in 1904, has always received the heavy sludge resulting from the sedimentation of sewage. The period of storage in this tank during 1907 was one hundred and twenty hours.

Sewage Entering and Effluents of Septic Tanks.

Sewage applied to Septic Tank A.

[Parts per 100,000.]

DATE.	Temperature (Deg. F.).	Free Ammonia.	KJELDAHL NITROGEN.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.			
December, 1906, to November, 1907, inclusive,	60	4.79	1.63	.70	14.85	7.17	1,160,800
Effluent of Septic Tank A.							
December, 1906, to November, 1907, inclusive,	62	5.51	0.90	.52	14.02	4.42	712,000
Sewage applied to Septic Tank F.							
December, 1906, to November, 1907, inclusive,	60	5.80	2.74	.73	14.56	9.14	1,752,500
Effluent of Septic Tank F.							
December, 1906, to November, 1907, inclusive,	63	7.27	0.82	.35	14.52	3.71	463,300

Solids in Sewage applied to and in Effluents of Septic Tanks.

Solids in Sewage applied to Septic Tank A.

[Parts per 100,000.]

	UNFILTERED.			FILTERED.			IN SUSPENSION.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
Average, . .	88.4	37.6	50.8	57.1	16.6	40.5	31.3	21.0	10.3
Solids in Effluent of Septic Tank A.									
Average, . .	64.0	20.5	43.5	52.9	13.1	39.8	11.1	7.4	3.7
Solids in Sewage applied to Septic Tank F.									
Average, . .	115.2	57.1	58.1	54.4	14.7	39.7	60.8	42.4	18.4
Solids in Effluent of Septic Tank F.									
Average, . .	60.8	16.2	44.6	47.5	7.5	40.0	12.3	8.7	4.6

STUDIES OF MEANS OF DISTRIBUTING SEWAGE UPON TRICKLING FILTERS.

During 1907 the tests of means of distributing sewage upon trickling filters, begun in 1906, were continued and many valuable data were obtained. The study so far has been an attempt to determine how to accomplish the most perfect distribution of sewage upon the surface of a sprinkling filter, and, while the experiments are by no means complete, a summary of the more important facts which were learned are here given.

The apparatus for making the tests has been moved into the station, where the investigation could proceed without interruptions on account of inclement weather, and it has been modified slightly. The principal modification is that the supply tank has been fixed at an elevation, and the variations in head are obtained by raising and lowering the platform upon which the collecting bottles and tunnels stand. This arrangement has enabled us to use permanent pipes of good size to connect the supply tank with the sprinklers, thus practically eliminating the effect of friction in the pipes upon the discharge.

The investigation has involved many hundred tests or runs of the testing apparatus, and consumed a considerable proportion of the time of two men during the summer of 1907. Considering each modification of the sprinkler proper as a different sprinkler, fifty-two different sprinklers have been tested, of which eight have been of the underfed, or nozzle, type, and forty-four have been of the overfed, or dash plate, type.

With the underfed nozzles, tests were made at all working heads between 2 feet and 8 feet under both constant and variable head, with the sprinklers placed both upon the surface and 1 foot above the surface; and with two of these nozzles the effect of varying the head through 2, 3 and 4 feet, respectively, and of placing the sprinkler at different elevations above the surface was studied. With the dash plate or overfed sprinklers the tests were all made under the same conditions, with the sprinklers placed 1 foot above the surface and an acting head of 5 feet. With this type the tests were confined to studies of the effect of using different-sized plates, of plates with rims turned up at different angles or with rims of different widths, and to the effect of different velocities of discharge obtained with orifices of different diameter. Three different types of dash plate were tested, two with an outer rim turned up at different angles, and one without any outer rim. With two types, plates varying in diameter from 2 inches to 6 inches were tested, and with another type plates with rims varying from 0.13 inch to 1 inch wide.

In combination with these plates five different discharging nozzles, with orifices varying in diameter from 0.25 to 0.75 inch, were tested. As the underlying principles of both underfed and overfed distribution by means of nozzles and deflectors are the same, the results obtained with either type are equally applicable to the other, and it has not been deemed necessary to duplicate all of the conditions of head under which the underfed sprinklers were tested in studying the dash plate sprinklers. In addition to these tests of the distribution upon the surface of filters, studies are in progress upon the effect of different depths and sizes of filtering materials in equalizing any considerable inequalities in distribution upon the surface of the filter.

With trickling filters the efficiency depends largely upon the application of the sewage uniformly over the whole surface, and the failure of otherwise well-designed filters of this type to produce an effluent of good quality may often be attributed to improper distribution. In England, where their development has been rapid, this principle is well recognized, and the problem has been studied at a large number of places, with the result that many types of sewage distributors have been devised. In most of these the sewage is distributed by a pipe or trough which travels over the surface of the filter, some types of distributors being moved by the head of the sewage, while others are driven by power. In still other types, distribution is accomplished by shallow troughs covering the whole surface of the filter, the sewage flowing either over the edge of the troughs or through perforations in the sides or bottom. By far the simplest, and for many reasons the most rational, system of distribution is by means of nozzles or spraying plates attached to fixed carriers; and systems of this kind have been installed at Salford and Birmingham, after comparative studies of a large number of different types. The nozzle systems are the logical outgrowth of the perforated pipes and jets used on a number of the earlier sprinkling filters; that is, the introduction of some form of a diffuser to break up the jets and spread the spray over a larger area. In this country the question of distribution upon sprinkling filters has been studied at Lawrence, Mass., Columbus, O., and elsewhere, but many of the fundamental data obtained in these tests have not as yet been published. At the Lawrence Experiment Station perforated pans with automatic tipping basins have been employed upon small experimental filters for more than ten years, and, when kept clean, have provided a satisfactory distribution. During two months in 1899 sewage was applied to a large experimental trickling filter at Andover through a grid or perforated pipes, from which numerous small jets shot up into the air and were more or less completely distributed by wind action. A number of measurements of flow and of the catch upon different portions of the surface of this filter were made, and a few attempts were made to improve the distribution by fastening strips of metal above the orifices to deflect and diffuse the flow. During five months of 1900 the distribution upon this filter was by means of perforated pipes elevated above the surface, with the orifices pointing downward, beneath each orifice being placed a flat piece of slate to spread the flow. This was probably the first application of the overhead carrier system combined with dash plates to distribute the flow upon sprinkling filters in this country, although this principle had been applied to experimental sand filters operated with both sewage and water almost from the beginning of the experiments at Lawrence.

A modification of this principle, in which the sewage is conveyed in elevated open troughs and discharges through orifices in the bottom, falling by gravity upon dash plates suspended at some distance below, instead of being conveyed in pipes and discharged through orifices under pressure upon dash plates, has been tried elsewhere and is said to have worked satisfactorily. From 1903 to 1906 the sewage was applied to the experimental filter at Andover by means of an automatic tipping basin which intermittently flushed one side of the bed and then the other, the distribution of sewage being assisted by sloping the surface away from the tipping basin. In June, 1906, the present method of distribution by means of an automatic flush tank connecting by overhead pipes with nozzles and dash plates was installed, this being described on page 244 of the report for 1906. The evolution from jets impinging upon pieces of slate used in 1900 to the system of nozzles and dash plates or to the elevated open troughs with orifices in the bottom and dash plates, was of course natural and inevitable.

A number of factors enter into a comparison of the efficiency of different sewage sprinklers. It is important that the rate of discharge and the size of the area wet be known. since upon these factors must be based the location of the sprinklers upon the filtration area. and the design of the carrier system to supply sewage to the sprinklers. Upon the uniformity with which the sewage is distributed over the surface and upon the rate at which it is applied depends in part the purification effected: while economy and ease of maintenance require that the construction of the sprinkler be such that it shall not be easily clogged, and may be readily cleaned in case clogging occurs. All of these factors must be considered in the selection of a type of sprinkler for any large area of trickling filters. In comparing the uniformity of distribution a number of methods may be used. In the report of the preliminary tests made in 1906, the per cent. of surface overdosed and of sewage applied was made the basis of comparison. This method does not show directly the size of the area wet, the mean rate at which the sewage is applied, nor the rate at which the sewage is applied to the overdosed area. A similar means of comparison is the coefficient of distribution devised by Phelps, in which an arbitrary factor, obtained by dividing the difference between the total discharge and the excess discharge upon the overdosed area by the total discharge, is used. This is merely another way of expressing the results shown by the percentages of overdosed area and of the sewage applied, from which the coefficient can be computed if desired. A direct ratio between the per cent. of overdosed area and the per cent. of sewage applied would be fully as useful as a means of comparing different sprinklers, besides being more easily understood. Another, and from many view points a more desirable, means of comparison, is by means of the relation between the mean rate of discharge upon the whole area and the rate upon the area receiving the greatest discharge. This method does not show the size of the area covered by the sprinkler, but includes directly or indirectly all of the other important factors, and enables us to form some idea as to the effect of the means of distribution upon the purification accomplished by the filter, which is, of course, the basis of the whole problem. In the following summary, all of these means of comparison are used as the circumstances seem to warrant.

Tests of Underfed Sprinklers.

The Columbus sprinkler consists of a brass nozzle with an orifice 0.56 inch in diameter, rounded on the lower side. Supported above this orifice by two thin arms is an inverted cone, the axis of the cone and the axis of the orifice being in the same plane. In the original design the angle of this cone was 90°, but for the purpose of experiment two other cones with angles of 102° and 120°, respectively, have been tried at Lawrence. The distance between the point of the cone and the orifice in the original design was ½ inch, and tests have also been made with the point of the cone lowered to the place of the orifice. The effect of the supporting arms was to deflect the spray out of its proper course, resulting in an unequal discharge upon different radii, the greater portion of the sewage which should fall upon the radii in the plane of the supports falling upon radii at an angle of about 30° with this plane.

As this study has been mainly one of principles, all results have been computed from the discharge upon the radii at right angles to the deflecting arms, where no interference has been caused by them. The actual distribution by this sprinkler is somewhat less uniform than the figures stated, for this reason.

Under the constant head the Columbus sprinkler with the 90° cone covered circles varying from 4 feet in diameter with 2 feet head to 17 feet in diameter with 8 feet head, with a discharge of from 5.25 to 13.05

gallons per minute, respectively. As the area wet by any nozzle increases much faster with the increase in head than does the discharge, the result is that the mean rate on the area wet decreases as the head increases, this rate being 27.16 million gallons per acre daily for 2 feet head, and 3.77 million gallons per acre daily for 8 feet head. The most uniform distribution was accomplished by this nozzle with the head of 7 feet when 82 per cent. of the sewage was applied to 43 per cent. of the total surface wet, the area covered being 14 feet in diameter, the mean rate being 4.98 million gallons per acre daily and the rate on the ring receiving the maximum overdose being 14.50 million gallons per acre daily, the coefficient of distribution being 61. Under variable head the most uniform distribution occurred with the nozzle 1 foot above the surface, a working distance of 8 feet, and variation in head of 2 feet. Under these conditions an area of 13 feet in diameter was wet, in which 71 per cent. of the sewage was applied to 38 per cent. of the surface, the distribution coefficient being 67.

Under constant head the Columbus nozzle with the 102° cone covered circles varying in diameter from 5 feet under 2 feet head to 18 feet under 8 feet head, the rate on the wet area being 19.70 million gallons per acre daily under the former head and 2.64 million gallons per acre daily under the higher head, and the discharge 5.97 and 11.90 gallons per minute, respectively. The most uniform distribution was accomplished by this nozzle under a head of 7 feet with the nozzle on the surface when 80 per cent. of the sewage was applied to 42 per cent. of the area wet, the area wet being 15 feet in diameter, the mean rate being 4.40 million gallons per acre daily and the rate on the ring receiving the maximum overdose being 10.70 million gallons per acre daily, the coefficient of distribution being 62. Under variable head the most uniform distribution occurred with the nozzle on the surface, a working distance of 8 feet and a variation in head of 3 feet. Under these conditions an area 15 feet in diameter was wet, in which 77 per cent. of the sewage was applied to 42 per cent. of the surface, the distribution coefficient being 65.

Under constant head the Columbus nozzle with the 120° cone covered circles varying in diameter from 5 feet under 2 feet head to 18 feet under 8 feet head, the rate on the wet area being 23.10 million gallons per acre daily under the former head and 3.50 million gallons per acre daily under the higher head, and the discharge 6.93 and 13.70 gallons per minute, respectively. The most uniform distribution was accomplished by this nozzle under a head of 7 feet with the nozzle 1 foot above the surface when 77 per cent. of the sewage was applied to 40 per cent. of the area wet, the area wet being 17 feet in diameter, the mean rate being 3.70 million gallons per acre daily and the rate on the ring receiving the maximum overdose being 9.50 million gallons per acre daily, the coefficient of distribution being 63. Under variable head the most uniform distribution occurred with the nozzle on the surface, a working distance of 8 feet and a variation in head of 3 feet. Under these conditions an area of 15 feet in diameter was wet, in which 77 per cent. of the sewage was applied to 42 per cent. of the surface, the distribution coefficient being 65.

With the Columbus nozzle tests were made with the point of the cone ½ inch above the orifice, the designed position, and with the point of the cone lowered to the plane of the orifice, the distance between the plane of the orifice and the point of the cone being called the impact distance. With all three cones the rate of discharge was reduced by bringing the cone closer to the orifice, the effect being to reduce slightly the diameter of the area wet, but as the spray was more broken up the distribution was made more uniform. The rate on the ring receiving the largest overdose with the 90° cone was only about three times the mean rate on the entire area wet when the point of the cone was at the plane of the orifice, but was about five times the mean rate when the point of the cone was ½ inch above it. With the 102° and 120° cones the rate on the ring receiving the largest overdose was only about twice the mean rate on the whole area when the point of the cone was lowered to the plane of the orifice; but when raised to its original position the rate on the ring receiving the maximum overdose was about five times the mean rate with the 102° cone and over three times the mean rate with the 120° cone.

The Birmingham sprinkler is similar in principle to the Columbus, differing in the fact that the cone is supported by a rod running through the orifice to a permanent fastening inside the nozzle, the water flowing up around this rod in the form of a hollow cylinder. The total diameter of the orifice is 0.38 inch, the diameter of the central rod is 0.13 inch, the angle of the cone is about 150° and the distance at which it is placed above the orifice is about 0.13 inch. With this nozzle the efficiency was somewhat greater than in the case of the Columbus nozzles, this being due in part to the somewhat smaller orifice of discharge and in part to the bringing of the deflecting cone nearer to the discharging orifice. With ports of such small size, however, it is evident that much trouble would be experienced with clogging, unless operated with a sewage entirely free from suspended matter.

Under constant head the Birmingham sprinkler covered circles varying in diameter from 7 feet under 2 feet head to 15 feet under 8 feet head, the discharge being 2.13 and 3.91 gallons per minute respectively, the rate on the wet area being 3.61 million gallons per acre daily under the lower head and 1.45 million gallons per acre daily under the higher head. The most uniform distribution was accomplished by this nozzle under a head of 5 feet with the nozzle on the surface when 44 per cent. of the sewage was applied to 27 per cent. of the area wet, this area being 13 feet in diameter, the mean rate being 2.35 million gallons per acre daily and the rate on the ring receiving the maximum overdose being 4.6 million gallons per acre daily, the coefficient of distribution being 83. Under variable head this nozzle was tested only with a variation in head of 4 feet, the most uniform distribution being obtained with the nozzle 1 foot above the surface, and a working distance of 7 feet. Under these conditions an area 13 feet in diameter was wet, in which 77 per cent. of the sewage was applied to 43 per cent. of the surface, the distribution coefficient being 66.

The principle upon which the Salford old-style sprinkler is based is entirely different from that of the Columbus and Birmingham types, the production of a spray depending upon the interference of two converging streams of water. The nozzle is an inverted hollow brass cone, with two orifices in the sides, each 0.25 inch in diameter, placed at an angle, from which the two streams meet just above the cup and unite to form a fan-shaped spray. The discharge upon different radii by this sprinkler is not the same, the area wet being shaped somewhat like a figure 8, with the greatest amount of sewage falling upon the centers of lobes. Owing to the small size of the orifices and the fact that they are placed at an angle, it is probable that in practice trouble would be experienced with clogging. For the purpose of comparison with other nozzles the area wet by this nozzle has been considered as an ellipse and the rings have been figured as elliptical rings. This method of computation was adopted as fairer than one based on circular rings, and as one by which proper allowance might be made for the spacing of the nozzles on large areas.

Under constant head the Salford old-style sprinkler covered elliptical areas varying in size from 4 by 2 feet under 2 feet head to 17 by 7 feet under 8 feet head, the rate on the wet area being 27.30 million gallons per acre daily under the lower head and 3.60 million gallons per acre daily under the higher head, and the discharge 2.64 and 5.13 gallons per minute, respectively. The most uniform distribution was obtained under a head of 7 feet with the nozzle 1 foot above the surface when 75 per cent. of the sewage was applied to 46 per cent. of the area wet, the dimensions of the area wet being 15 by 7 feet, the mean rate being 5.2 million gallons per acre daily and the rate on the ring receiving the maximum overdose being 14.6 million gallons per acre daily, the coefficient of distribution being 71. Under variable head the sprinkler was tested only with a variation in head of 4 feet, and the distribution was much less uniform than under constant head, the effect of varying the head being to concentrate a considerable proportion of the sewage upon a small area near the nozzle. Under these conditions the most uniform distribution occurred with the nozzle on the surface and a working distance of 8 feet, the dimensions of the area wet being 15 by 6 feet within which 68 per cent. of the sewage was applied to 24 per cent. of the surface, the coefficient of distribution being 56.

The Salford new-style sprinkler is constructed upon still another principle, the production of the spray depending upon the whirling motion imparted to the column of sewage within the nozzle before being discharged from the orifice. The nozzle consists of a hollow brass cone with an orifice at the top 0.38 inch in diameter, with rounded outer rim. Screwed into the bottom of this hollow cone is a flat disk of brass with a solid cone in the center, the plate being pierced by six orifices, each 0.16 inch in diameter, spaced at regular intervals around the base of the cone. The axes of these orifices are inclined at an angle of about 30° with the major axis of the cone, with the result that a whirling motion is produced within the chamber between the inner and outer cones, and the stream of sewage is broken up by centrifugal force upon leaving the orifice in the outer cone. This nozzle is cleaned with difficulty when it becomes clogged, as must frequently occur in practice, owing to the small size of the ports and the devious course which the sewage has to traverse. The areas covered by this sprinkler have been much smaller than those covered by either the Columbus or Birmingham types, owing to the considerable loss of head within the nozzle, but the distribution upon them has been very uniform. Under constant head the Salford new-style sprinkler covered circles varying in diameter from 4 feet under 2 feet head to 14 feet under 8 feet head, the rate on the wet area being 6.6 million gallons per acre daily under the former head and 1.4 million gallons per acre daily under the latter head, and the discharge 1.25 and 3.30 gallons per minute, respectively. The most uniform distribution was obtained with this nozzle under a head of 5 feet with the nozzle on the surface when 76 per cent. of the sewage was applied to 51 per cent. of the area wet, the area wet being 9 feet in diameter, the mean rate being 2.6 million gallons per acre daily, the rate on the ring receiving the maximum overdose being 4.3 million gallons per acre daily, and the coefficient of distribution being 75. Under variable head the sprinkler was tested with a variation in head of 4 feet only, the most uniform distribution being obtained with the nozzle on the surface, and a working distance of 7 feet. Under these conditions an area 11 feet in diameter was wet, in which 75 per cent. of the sewage was applied to 41 per cent. of the surface, the distribution coefficient being 68.

Studies with Dash Plates.

In this type of sprinkler the sewage was conveyed overhead to a brass nozzle 3 inches long, of uniform bore, through which it discharged downward upon a dash plate placed immediately below, the dash plate being supported upon a separate standard independent of the discharging orifice. All of the plates have been tested under a uniform working distance of 6 feet with a head of 5 feet, the plate being placed 1 foot above the surface and 1 inch below the orifice. This part of the investigations has been confined to studies of the effect of using plates of various sizes, of using plates with deflecting rims turned up at different angles, of having the deflecting rims of different widths, and to the variations produced by the use of orifices of different diameters and different rates of discharge.

The Type A dash plate is a flat plate with a rim about 0.25 inch wide, turned up at an angle of 20°. Five of these plates have been used, varying in diameter from 2 inches to 6 inches, each of which was tested under 5 feet constant head and under a variation in head of 4 feet with five different nozzles, having orifices ranging from 0.25 inch in diameter to 0.75 inch in diameter. The plate 2 inches in diameter gave a more satisfactory distribution than did any of the larger, although even with this the distribution was less uniform than was the case with some of the underfed sprinklers. The effect of increasing the diameter of the plate has been to retard the flow, so that a smaller area has been wet; in fact, with the larger plates the friction was so great that when using the smallest orifice the area wet was only about 2 feet in diameter. With the 2-inch plate and an orifice 0.25 inch in diameter an area 9 feet in diameter was wet, the rate of discharge being 2.4 million gallons per minute, corresponding to a mean rate of 2.5 million gallons per acre daily upon the wet area. In this test the maximum rate upon the overdosed area was 5.8 million gallons per acre daily, and 78 per cent. of the sewage was applied to 41 per cent. of the surface, the coefficient of distribution being 63. This was the best result obtained in any of the tests with this type of plate. An interesting fact noted in these tests was that under constant head the diameter of the area wet was less in every case when an orifice 0.75 inch in diameter was used than with one 0.63 inch in diameter, notwithstanding the fact that the rate of discharge was proportionately greater with the larger orifice. Under variable head the distribution by this type of plate was much more uniform with large than with the smaller orifices. The best results under variable head were obtained with a 2-inch plate and an orifice of 0.63 inch in diameter. Under these conditions an area 12 feet in diameter was wet, 81 per cent. of the sewage was applied to 44 per cent. of the surface, and the distribution coefficient was 63.

The Type B dash plate is a perfectly flat circular plate, and has been tested under the same conditions as those described under Type A. Under these conditions five plates, varying in diameter from 2 inches to 6 inches, have been each tested with three nozzles, having orifices of 0.25, 0.50 and 0.75 inch, respectively. The results obtained in these tests have been similar to those obtained with the Type A plate, the principal difference being in the somewhat smaller areas covered. With the larger plates the diameter of the wet area has been less than with the smaller, these areas ranging from 6 to 10 feet with the 2-inch plate when combined with different nozzles. Under constant head the uniformity of distribution was greater with the smaller orifices, although this did not hold true when the sprinklers were operated under variable head. The best result under constant head was obtained with a 4-inch plate and 0.25-inch orifice when a distribution coefficient of 57 was obtained, the area covered, 4 feet in diameter, being so small, however, that the sprinkler could have no practical value. Under variable head the highest coefficient obtained was also 57, but in this case the area covered by the sprinkler was 8 feet in diameter, upon which 76 per cent. of the sewage was applied to 33 per cent. of the surface.

The Type C dash plate is a flat plate 2 inches in diameter, with an outer rim turned up at an angle of 45°. With this type of plate the studies were confined to an investigation of the effect of varying the width of the upturned rim, and four different plates, having rims 0.13, 0.25, 0.50 and 1 inch wide, respectively, were tested with a single orifice 0.50 inch in diameter, under the conditions previously described under Types A and B. Under constant head the areas wet were slightly less with the larger plates than with the smaller, the distribution being somewhat more uniform with the smallest and the largest plate than with the other two. The best result under constant head was obtained with the plate having a rim only 0.13 inch wide, an area 13 feet in diameter being covered, upon 27 per cent. of which area 70 per cent. of the sewage was applied. The rate on the wet area in this test was 4.9 million gallons per acre, the maximum rate on the overdosed area being 16.2 million gallons per acre daily and the coefficient of distribution being 57. The results obtained under variable head with the three plates having the wide rims were practically identical, the distribution coefficients being 51, 49 and 51, respectively, the results obtained with the plate having the narrowest rim being somewhat better than with the other plates.

With this plate an area 11 feet in diameter was wet, 83 per cent.. of the sewage being concentrated upon 40 per cent. of the surface, with a distribution coefficient of 57.

In the foregoing the results of varying a number of conditions upon the work of individual sprinklers have been stated. The following account is of the relative behavior of these sprinklers when tested under uniform conditions. As the dash plate types were tested only under a 5-foot head with the sprinkler 1 foot above the surface, these are the conditions under which comparisons must be made; and, as the Type C plate was only 2 inches in diameter and was tested only with an orifice 0.50 inch in diameter, this imposes the conditions under which the Type A and Type B plates must be included. When operated with constant head under these conditions the Birmingham and Salford new-style sprinklers were most effective, having coefficients of distribution of 71 each; and, since the Birmingham sprinkler covered an area 15 feet in diameter and the Salford sprinkler covered an area only 11 feet in diameter, the former type may be said to be better than the latter. It would be practicable to operate either of these two sprinklers continuously under these conditions, since their mean rates were only about 1.7 million gallons per acre daily, and the maximum rates on the overdosed areas were only about twice that amount. The Type A dash plate sprinkler was next in order of efficiency, with a coefficient of 56, with the Columbus 90° cone, the Columbus 120° cone, the Type C dash plate and the Columbus 102° cone following in the order named, with coefficients of 52, 50, 50 and 48, respectively, and areas wet between 13 and 15 feet in diameter. The Type B dash plate was the least efficient of the ring sprinklers, having a covering power of only 10 feet and a coefficient of 45. The Salford old-style sprinkler must be classed below any of the others, because, while it had a coefficient of distribution of 51, the area covered by it was much less than by any of the other sprinklers. With a variation in head of 4 feet, the difference in the efficiency of the different ring sprinklers was much less than when tested under constant head. The most efficient was the Birmingham nozzle, with a coefficient of 63 and a covering power of 12 feet. Taking both covering power and uniformity of distribution into account, the other ring sprinklers would rank in the following order: Type A dash plate; Columbus 120° cone; Columbus 102° cone; Type C dash plate; Salford new-style; Columbus 90° cone; Type B dash plate; with coefficients varying between 59 and 49, and covering powers between 12 feet and 8 feet. The Salford old-style sprinkler had a coefficient of only 34 under variable head, falling far below the ring sprinkler in point of efficiency and covering power. The results of the tests of these sprinklers under the conditions named, with both constant and variable head, are shown in the following table: —

Table showing Relative Efficiency of Different Sprinklers when operated with Sprinkler Set 1 Foot above Surface and 6 feet Working Distance.

Five Feet Constant Head.

TYPE OF SPRINKLER.	DIAMETER (FEET).		RATE OF FLOW.			Per Cent. of Surface overdosed.	Per Cent. of Sewage applied to Overdosed Area.	Coefficient of Distribution.
	Of Area wet.	Of Ring receiving Largest Overdose.	Gallons per Minute.	MILLION GALLONS PER ACRE DAILY.				
				On Area wet.	On Ring receiving Largest Overdose.			
Columbus, 90°,	13	7	10.12	5.00	19.8	33	81	52
Columbus, 102°,	15	9	14.20	5.25	19.5	38	90	48
Columbus, 120°,	15	9	10.40	3.85	17.5	23	73	50
Birmingham,	15	10	4.65	1.72	3.5	53	82	71
Salford, new-style,	11	7	2.45	1.69	3.4	47	76	71
Salford, old-style,	11 × 6[1]	6 × 1[1]	3.42	4.32	22.7	36	85	51
Dash plate A,	13	8	7.90	3.91	11.3	38	82	56
Dash plate B,	10	6	9.47	8.96	32.5	33	88	45
Dash plate C,	13	7	9.57	4.74	19.0	28	78	50
Head Varied between Five Feet and One Foot.								
Columbus, 90°,	11	2	-	-	-	30	81	49
Columbus, 102°,	12	3	-	-	-	34	80	54
Columbus, 120°,	12	3	-	-	-	44	87	57
Birmingham,	12	3	-	-	-	44	81	63
Salford, new-style,	10	2	-	-	-	36	77	59
Salford, old-style,	9 × 4[1]	1 × 1[1]	-	-	-	17	83	34
Dash plate A,	12	3	-	-	-	42	84	58
Dash plate B,	8	4	-	-	-	39	84	55
Dash plate C,	11	3	-	-	-	40	83	57

[1] Axes of ellipse.

In considering the subject of distribution, the question naturally arises as to whether the material in a filter would further distribute the sewage falling upon its surface and equalize the very varying quantities discharged upon adjacent areas by sprinklers such as those tested. Studies to determine this point are in progress, sewage being distributed upon the surface of the filtering material by a sprinkler, and determinations being made of the volumes falling upon different portions of the surface and of the volumes flowing from the same areas after passing through different depths of filtering material. So far as these experiments have gone, they indicate that under practical conditions the filtering material does not effect any equalization of the discharge upon its surface; in fact, the reverse appears to be true at times, as in the case when a considerable volume of sewage falls upon a narrow ring, and the volumes falling upon the adjacent rings are relatively small, in which case the volume passing the ring of maximum discharge is greater than it was at the surface, and the volumes passing the adjacent rings are proportionately less. This effect is probably caused by the formation of channels through the material through which the larger volumes pass rapidly, and by the tendency of the sewage in the less wet areas to take the course of least resistance and flow toward these waterways. This effect is especially marked in measurements made within a short time after the sewage is applied to the surface, and has been observed in smaller degree when the filtering material has been allowed to drain completely.

Conclusions.

From the results obtained in the few percolation tests made, it must be concluded that it cannot be expected that the material in the filters will perform the work of distribution which rightly should be accomplished by the sprinklers, and that attention must be devoted to improving their construction if a more uniform distribution is to be obtained. Experience with experimental trickling filters has shown that good purification may be obtained when they are operated at certain rates, but that when operated at excessively high rates the results are extremely poor. From the experiments with the sprinklers it is seen that, while the mean rate upon the area wet may be kept down to the point where good purification is assured, small portions of this area are receiving the bulk of the sewage at rates many times greater than practical, while the larger portion of the filter is being operated at a very low rate. The result is that a considerable proportion of the sewage may pass through the filter practically unchanged and a small portion be highly purified; in other words, the effluent from the filter may be a mixture of highly purified effluent and of practically unpurified sewage, rather than a uniformly purified effluent.

The sprinkler tests have shown that as the head is increased, the size of the area covered by any sprinkler and the rate of discharge by the sprinkler increase, but that the mean rate on the area wet diminishes. These tests have shown, also, that nearly all sprinklers are more efficient in producing uniform distribution when operated at the higher heads, and that only a small variation in this efficiency is produced by elevating the sprinkler above the surface. The rates obtained with nearly all of the sprinklers have been so large that they could not be operated continuously without causing the filter to be flooded at much higher rates than are at present believed to be advisable; and for this reason a system of distribution by sprinklers of any of these types should also include some device for producing intermittent operation. Operating the sprinklers under variable head has resulted in wetting the portion of the surface adjacent to the sprinkler which was entirely overthrown by the same sprinkler under constant head; but this more complete wetting has not resulted in any material increase in the uniformity of distribution, since a greater volume of sewage is concentrated upon a smaller overdosed area. The shape of the area wet by a sprinkler, such as the Salford old-style nozzle, in which the spraying is produced by the interference of two jets, is not such as to lend itself readily to the economical placing of the sprinklers on large areas; and the use of external arms to support the deflecting cone in nozzles such as the Columbus type results in a very unequal distribution of the sewage upon different radii, in addition to the inequalities normal to ring sprinklers of this class. Nozzles such as the Salford new style, which produce a whirling spray, seem to produce a more uniform distribution than most sprinklers of the deflecting cone or dash plate type; but the design is such that trouble must be experienced with clogging unless a sewage remarkably free from suspended matter be used. With the types of sprinklers in which the flow is broken up and deflected by cones or dash plates, the angle at which the spray is projected has considerable influence upon the uniformity of distribution, especially when the sprinkler is operated at higher heads, the best results being obtained generally when the spray is projected at an angle of 15° to 20° above the horizontal. With the cone sprinklers more uniform distribution is produced when the cone is placed close to the orifice than when it is placed some distance away, as is shown by the superior work of the Birmingham nozzle and of the relative work of the Columbus nozzles with the cones placed in different positions. From the studies with dash plates and from the relative performance of the Columbus and Birmingham nozzles it has been learned that the distribution is better with small orifices than with large ones, and that it is advisable to keep the size of the orifice of discharge as small as is consistent with freedom from clogging.

Studies of Storage of Matter in Contact and Trickling Filters.

During the year five contact and six sprinkling or trickling filters were operated. A detailed discussion of the results of operation of these filters is given on pages 216–220, inclusive. In the last report a summary was given showing the per cent. of oxidation of the organic matter in the sewage applied to these filters, and the per cent. of storage of total matter and organic matter of the applied sewage.

SAND FILTERS, 1/200 OF AN ACRE IN AREA, NOS. 1, 2, 4, 5C, 6, 9A AND 10.

At the end of 1907, Filters Nos. 1, 2, 4 and 6 had been operated nearly twenty years, these filters having been started early in 1888; Filters Nos. 9A and 10 had been operated seventeen and thirteen years, respectively. Since 1893, a period of fourteen years, these filters have been operated without removal of surface sand. The actual volume of sewage applied to each of these filters, up to Dec. 1, 1907, is shown in the following table: —

Average Rate of Operation and Volume of Sewage applied to Sewage Filters, 1/200 of an Acre in Area, from Date of Start to Dec. 1, 1907.

FILTER NOS.	Date started.	Number of Days operated.	Average Rate of Operation (Gallons per Acre).	Actual Gallons applied.
1, ...	Jan. 1, 1888	6,264	68,800	2,158,552
2, ...	Dec. 19, 1887	6,274	36,400	1,138,916
4, ...	Dec. 19, 1887	6,274	23,000	720,526
5C, ...	July 20, 1905	768	50,700	196,250
6, ...	Jan. 1, 1888	6,264	56,200	1,740,004
9A, ...	Nov. 18, 1890	5,361	67,700	1,658,469
10, ...	July 18, 1894	4,215	27,200[1]	536,435

[1] Rate on area flooded, 108,800 (see page 209).

Filter No. 1.

Filter No. 1, constructed of 60 inches of sand of an effective size of 0.48 millimeter, is 1/200 of an acre in area, and was first put into operation on Jan. 10, 1888. The filter was operated at a rate of 60,000 gallons per acre daily for six days in a week from Dec. 1, 1906, to Jan. 31, 1907; at 50,000 gallons from February 1 to May 31; at 30,000 gallons from June 1 to June 14; and at 64,000 gallons from June 14 to November 30. From March 18 to March 31 the filter was flooded three times a week only, and after June 1 weak sewage was applied; that is, the sewage as pumped was diluted with canal water. This was done also with Filters Nos. 2, 4, 6, 9A and 10, in order to compare the quality of the effluent obtained when the filters were operated with this comparatively weak sewage in 1907 with the quality of effluent obtained when they were operated with sewage of about the same strength early in the history of the station, when they were new and contained little stored organic matter. From December 1 to

March 12 the surface of the filter was trenched and the trenches were covered with boards, as described in previous reports. Measurements were made on February 1 and February 13 of the comparative temperature of the air in the trenches and the outside air. On February 1 the air in the trenches just before flooding the filter was 7 degrees warmer, thirty minutes after flooding it was 21 degrees warmer, and four hours after flooding it was 15 degrees warmer than the outside air, the temperatures of the outside air and of the sewage at the time of flooding being respectively 26° F. and 61° F. On February 13 the air in the trenches was 22 degrees warmer at time of flooding, 24 degrees warmer one hour after flooding, and 14 degrees warmer five hours after flooding, the temperature of the outside air and of the sewage at time of flooding being 4° F. and 60° F., respectively. On March 12 the board covers were removed. Snow, averaging 2 inches in depth, was removed from the surface of the filter on four different dates after the board covers were removed. On April 6 the sand in the trenches was raked 3 inches deep, the surface of the filter was levelled and the whole filter dug over to a depth of 8 inches. The filter was allowed to rest July 1 to July 7, and November 8 to November 10, inclusive. The surface of the trenches was raked 1 inch deep once in December; twice in January; once in March; twice in November; and the whole surface of the filter was raked once a week during the period when it was level. On November 18 the surface was again trenched.

Filter No. 2.

Filter No. 2, constructed of 60 inches of fine sand of an effective size of 0.08 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of the sand being below the surface of the remainder of the filter, and to them the sewage was applied at the rate of 40,000 gallons per acre daily from December 1 to May 31; at 30,000 gallons from June 1 to June 13; and at 32,000 gallons from June 14 to November 30. From Macrh 18 to April 5 and from April 6 to April 14 the filter was flooded only three times a week, and the sewage applied was diluted with canal water. From Dec. 1, 1906, to March 12, 1907, the trenches were covered with boards. Snow, averaging 2 inches in depth, was removed from the trenches on four different dates after the board covers were removed. On February 22 and on April 3 the trenches were dug over 8 to 10 inches deep. On May 7 the coarse sand in the trenches was removed, the sides of the trenches were scraped, the bottom dug over 6 inches deep and the coarse sand replaced. On June 11 the grass and weeds growing on the filter were cut. On July 6 the trenches were dug over to a depth of 3 inches. On November 20 the trenches were again dug over to a depth of 12 inches. The surface of the trenches was raked 1 inch deep twice in January, once in February and once a week during the remainder of the year. The filter was allowed to rest April 1 to April 14, May 2 to May 13, July 1 to July 7 and November 8 to November 10, inclusive.

Filter No. 4.

Filter No. 4, constructed of 60 inches of fine river silt of an effective size of 0.04 millimeter, is 1/200 of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches about 14 inches wide and 12 inches deep, of coarse sand of an effective size of 0.48 millimeter, the surface of the sand being below that of the remainder of the filter, and to them the sewage was applied at the rate of 40,000 gallons per acre daily three times a week from Dec. 1, 1906, to May 31, 1907; at 30,000 gallons from June 1 to June 14; and at 40,000 gallons from June 15 to November 30. After June 1 the sewage applied was diluted with canal water. From December 4 to March 12 the trenches were covered with boards. Snow, averaging 2 inches in depth, was removed from the trenches on four different dates after the board covers were removed. On April 6 the trenches were dug over 8 inches deep. On May 2 the coarse sand in the trenches was removed, the sides of the trenches scraped, the bottom dug over 6 inches deep and the coarse sand replaced. The surface of the trenches was raked to a depth of 3 inches on July 6, and on November 12 was again dug over to a depth of 12 inches. On June 11 the grass and weeds growing on the ridges were cut. The surface of the trenches was raked 1 inch twice in January, three times in March and once a week during the remainder of the year. The filter was allowed to rest May 2 to May 8, July 1 to July 7 and November 8 to November 10, inclusive.

Filter No. 5C.

Filter No. 5C, constructed of 60 inches of sand of an effective size of 0.22 millimeter, is 1/200 of an acre in area, and was first put into operation on July 20, 1905. The filter was operated at a rate of 50,000 gallons per acre daily for six days in the week throughout the year. From March 18 to March 31 the filter was flooded only three times a week. From December 1 to March 12 the surface of the filter was trenched and the trenches were covered with boards. Measurements were made on January 28, January 31 and February 4 of the comparative temperature of the air in the trenches and of the outside air. On January 28 the air in the trenches just before flooding the filter was 23 degrees warmer, fifteen minutes after flooding it was 33 degrees warmer, and one hour after flooding it was 30 degrees warmer than the outside air, the temperatures of the outside air and of the sewage at the time of flooding being respectively 13° F. and 61° F. On January 31 the air in the trenches was 8 degrees warmer at time of flooding, 36 degrees warmer ten minutes after flooding, and five hours after flooding 26 degrees warmer than the outside air, the temperature of the outside air and of the sewage at time of flooding being 21° F. and 61° F. respectively. On February 4 the air in the trenches was 13 degrees warmer at time of flooding, 19 degrees warmer forty minutes after flooding and 14 degrees warmer four hours after flooding, the temperature of the outside air and of the sewage at time of flooding being 18° F. and 60° F. respectively.

Snow, averaging 2 inches in depth, was removed from the surface of the filter on three different dates after the board covers were removed.

On April 6 the sand in the trenches was raked 3 inches deep, the surface of the filter was levelled and the whole filter dug over to a depth of 8 inches. The filter rested from July 1 to July 7 and from November 8 to November 10, inclusive.

The surface of the trenches was raked 1 inch deep once in December, twice in January, and once a week during the remainder of the year. On November 20 the surface was again trenched for the winter.

Filter No. 6.

Filter No. 6, constructed of 44 inches of mixed coarse and fine sand of an effective size of 0.35 millimeter, is $1/200$ of an acre in area, and was first put into operation on Jan. 12, 1888. The filter was operated at the rate of 60,000 gallons per acre daily for six days in the week from Dec. 1, 1906, to Jan. 31, 1907; at 50,000 gallons from February 1 to May 31; at 30,000 gallons from June 1 to June 13; and at 42,000 gallons from June 15 to November 30. From March 18 to April 7 and from April 15 to May 6 the filter was flooded only three times a week, and after June 1 the sewage applied was diluted with canal water. From December 1 to March 12 the surface of the filter was trenched and the trenches were covered with boards. Measurements were made on February 1 and February 7 of the comparative temperature of the air in the trenches and of the outside air. On February 1 the air in the trenches just before flooding the filter was 9 degrees warmer, one and one-half hours after flooding it was 17 degrees warmer and four and one-half hours after flooding it was 15 degrees warmer than the outside air, the temperature of the outside air and of the sewage at the time of flooding being respectively 25° F. and 60° F. On February 7 the air in the trenches was 20 degrees warmer at time of flooding, 45 minutes after flooding 33 degrees warmer and four hours after flooding 25 degrees warmer than the outside air, the temperature of the outside air and of the sewage at time of flooding being 13° F. and 59° F. respectively.

Snow, averaging 2 inches in depth, was removed from the surface of the filter on three different dates after the board covers were removed. On March 5 the sand in the trenches was dug over 6 inches deep.

On April 3 the sand in the trenches was raked 3 inches deep, the surface of the filter was levelled and the whole filter dug over to a depth of 6 inches. On May 1 the surface of the filter was dug over to a depth of 10 inches and on July 6 it was raked to a depth of 3 inches. The filter rested from April 1 to April 5, May 1 to May 7, July 1 to July 7, September 28 to September 30, and November 8 to November 10, inclusive.

On November 20 the surface was trenched for the winter. The surface of the trenches was raked 1 inch deep once in December, twice in January, once in February, once in March and once in November, and the whole surface of the filter was raked 1 inch deep weekly during the period when it was level.

Filter No. 9A.

Filter No. 9A, constructed of 60 inches of sand of an effective size of 0.17 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Nov. 18, 1890. The filter was operated at the rate of 60,000 gallons per acre daily for six days in the week from Dec 1, 1906, to Jan. 31, 1907; at 50,000 gallons from February 1 to May 31; at 100,000 gallons from June 1 to June 14; and at 70,000 gallons from June 15 to November 30. From March 18 to April 3 the filter was flooded only three times a week, and after June 1 the sewage applied was diluted with canal water. From December 1 to March 12 the surface of the filter was trenched and the trenches were covered with boards. Measurements were made on February 1, February 4 and February 13 of the comparative temperature of the air in the trenches and of the outside air. On February 1 the air in the trenches just before flooding the filter was 14 degrees warmer, one and three-fourths hours after flooding it was 18 degrees warmer and five hours after flooding it was 15 degrees warmer than the outside air, the temperature of the outside air and of the sewage at the time of flooding being respectively 33° F. and 62° F. On February 4 the air in the trenches was 22 degrees warmer at time of flooding, 25 degrees warmer two hours after flooding, and four hours after flooding 11 degrees warmer than the outside air, the temperature of the outside air and of the sewage at time of flooding being 11° F. and 60° F., respectively. On February 13 the air in the trenches was 27 degrees warmer at time of flooding, 32 degrees warmer one hour after flooding, and five hours after flooding it was 10 degrees warmer than the outside air, the temperature of the outside air and of the sewage at time of flooding being 0° F. and 63° F., respectively.

Snow, averaging 2 inches in depth, was removed from the surface of the filter on four different dates after the board covers were removed. On March 15 the trenches were dug over 8 inches deep.

On April 6 the sand in the trenches was raked 3 inches deep, the surface of the filter was levelled and the whole filter dug over to a depth of 8 inches. The filter rested from March 13 to March 15, July 1 to July 7, September 28 to September 30, and November 8 to November 10, inclusive.

The surface of the trenches was raked 1 inch deep once in December, twice in January, once in February, once in March and once in November, and the whole surface of the filter was raked 1 inch deep weekly during the period when it was level. On November 20 the surface was trenched for the winter.

Filter No. 10.

Filter No. 10, 1/200 of an acre in area, is constructed of 5 feet of fine and coarse mixed sand of an effective size of 0.35 millimeter, and was first put into operation on July 18, 1894. No underdrains are beneath the sand except directly above and around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface which is farthest from the underdrains from the remainder of the surface. To this quarter the sewage is applied, and over the remainder of the surface is a layer of loam 8 inches in depth. Sewage was applied at the rate of 25,000 gallons per acre daily six times a week from Dec. 1, 1906, to May 31, 1907; at 160 gallons from June 1 to June 14; and at 40,000 gallons from June 15 to November 30. From March 18 to April 3 and from June 1 to June 14, inclusive, the filter was flooded only three times a week, and after June 1 the sewage applied was diluted with canal water. On March 15 and on April 6 the filter was dug over to a depth of 8 inches, on July 6 to a depth of 3 inches, on August 19 to a depth of 12 inches and on November 20 to a depth of 6 inches. That portion of the surface to which sewage was applied was raked to a depth of 1 inch twice in December, once in January, once in February, twice in March and once a week during the remainder of the year. Snow and ice were removed from the surface of the filter as follows: in December, 3½ inches of snow and ¼ inch of ice; in January, 13 inches of snow and ½ inch of ice; in February, 29 inches of snow and 2½ inches of ice; in March, 5½ inches of snow and 1 inch of ice; and in April, 6 inches of snow. The filter was rested March 13 to 15, July 1 to 7, August 12 to 19 and November 8 to 10, inclusive.

Effluent of Filter No. 1.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.													
December, .	55,400	61	43	1h. 18m.	2.3	.78	2.7400	.1550	13.00	1.34	.0054	1.67	7,650
1907.													
January, .	57,800	60	43	58m.	0.8	.69	2.9200	.1440	12.70	2.48	.0034	1.45	12,400
February, .	50,000	61	41	1h. 46m.	0.8	.64	2.7000	.1080	11.00	3.40	.0024	1.10	4,700
March, . .	38,500	59	42	1h. 26m.	0.4	.48	2.6000	.0930	11.20	4.82	.0090	1.01	3,050
April, . .	48,100	57	46	15m.	0.4	.39	1.3000	.0780	12.55	6.38	.0080	0.85	2,200
May, . .	50,000	56	54	4m.	0.0	.28	0.3490	.0560	14.90	7.81	.0051	0.68	675
June, . .	43,900	63	64	3m.	0.0	.19	0.0458	.0426	9.70	6.01	.0005	0.54	935
July, . .	40,300	72	71	2m.	0.0	.13	0.0243	.0392	10.10	5.59	.0002	0.48	3,000
August, . .	56,900	71	71	2m.	0.0	.12	0.0103	.0244	8.65	3.83	.0004	0.38	800
September, .	53,800	66	68	6m.	0.0	.13	0.0179	.0235	7.41	2.86	.0002	0.49	2,425
October, . .	61,600	56	57	7m.	0.3	.16	0.0524	.0264	5.70	2.26	.0002	0.48	2,200
November, .	51,700	54	48	39m.	0.2	.15	0.1670	.0300	5.00	2.35	.0012	0.48	3,750
Average, .	50,700	61	54	34m.	0.4	.35	1.0772	.0683	10.16	4.09	.0030	0.80	3,650

Solids in Effluent of Filter No. 1.

[Parts per 100,000.]

DATE.	Total.	Loss on Ignition.	Fixed.
1906.			
December, ...	41.0	10.2	30.8
1907.			
January, ...	42.4	10.3	32.1
February, ...	46.8	12.2	34.6
March, ...	61.7	16.7	45.0
April, ...	82.3	24.1	58.2
May, ...	92.7	24.8	67.9
June, ...	72.7	25.0	47.7
July, ...	69.4	26.1	43.3
August, ...	45.4	11.8	33.6
September, ...	40.3	9.6	30.7
October, ...	28.0	5.5	22.5
November, ...	29.9	7.6	22.3
Average, ...	54.4	15.3	39.1

Effluent of Filter No. 2.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.													
December, .	40,000	60	43	1h. 38m.	.0	0.13	0.9490	.0460	11.98	3.39	.0145	0.44	66
1907.													
January, .	38,500	60	40	1h. 31m.	.0	0.15	1.8275	.0490	11.90	1.38	.0410	0.54	53
February, .	38,300	60	40	3h. 30m.	.0	0.30	2.1625	.0680	11.70	0.92	.0520	0.66	73
March, . .	30,800	59	41	–	.1	0.76	1.5800	.1300	9.35	0.81	.0160	1.66	630
April, . .	22,400	58	45	2h. 55m.	.1	1.01	2.9600	.1620	10.65	2.79	.0046	2.12	100
May, . .	23,700	57	53	8m.	.0	0.53	3.7600	.0940	14.20	6.38	.0024	0.86	120
June, . .	28,600	63	60	2m.	.0	0.21	1.3775	.0660	12.45	7.02	.0004	0.70	130
July, . .	20,100	71	66	2m.	.1	0.26	0.2888	.0396	10.00	5.84	.0002	0.59	93
August, . .	29,600	71	69	2m.	.1	0.24	0.0219	.0287	9.05	3.70	.0002	0.44	210
September, .	30,700	66	67	2m.	.0	0.18	0.0036	.0240	7.10	3.32	.0002	0.46	75
October, . .	30,800	56	57	4m.	.1	0.17	0.0029	.0210	4.75	2.36	.0008	0.43	210
November, .	24,600	54	49	8m.	.1	0.08	0.0012	.0148	5.60	3.19	.0000	0.30	585
Average, .	29,800	61	53	55m.	.0	0.34	1.2446	.0619	9.89	3.43	.0110	0.77	200

Solids in Effluent of Filter No. 2.

[Parts per 100,000.]

DATE.	Total.	Loss on Ignition.	Fixed.
1906.			
December, ...	39.0	9.5	29.5
1907.			
January, ...	36.1	9.3	26.8
February, ...	33.5	6.8	26.7
March, ...	32.0	7.9	24.1
April, ...	52.4	6.2	46.2
May, ...	81.3	32.2	49.1
June, ...	75.9	26.3	49.6
July, ...	69.5	21.4	48.1
August, ...	49.5	8.0	41.5
September, ...	42.7	8.3	34.4
October, ...	28.9	5.0	23.9
November, ...	35.4	5.5	29.9
Average, ...	48.0	12.2	35.8

Effluent of Filter No. 4.

[Parts per 100,000.]

Date.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.).		Length of Time Sewage remained on Surface.	Appearance.		Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.													
December, .	20,000	61	43	55m.	0.0	.05	0.0630	.0165	12.45	4.89	.0002	0.72	125
1907.													
January, . .	21,500	60	41	26m.	0.0	.05	0.3893	.0220	9.70	3.06	.0059	0.29	240
February, .	20,000	60	40	29m.	0.1	.09	1.1800	.0420	10.55	4.13	.0350	0.31	620
March, . .	20,000	59	40	39m.	0.0	.05	1.2700	.0330	9.35	3.62	.0360	0.42	112
April, . .	18,500	58	45	10m.	0.0	.07	1.5500	.0350	9.35	4.57	.0580	0.33	65
May, . .	14,800	57	51	4m.	0.0	.07	1.1325	.0260	11.10	6.08	.0530	0.39	34
June, . .	18,400	63	59	3m.	0.0	.08	0.3123	.0333	12.65	7.63	.0140	0.51	39
July, . .	11,900	71	66	2m.	0.1	.04	0.0298	.0228	10.70	5.42	.0001	0.45	63
August, . .	19,300	71	67	1m.	0.0	.07	0.0074	.0185	8.55	3.24	.0001	0.21	430
September, .	19,200	66	67	1m.	0.0	.05	0.0030	.0134	8.35	2.73	.0001	0.25	9
October, . .	20,700	56	57	4m.	0.0	.04	0.0023	.0117	5.48	2.15	.0000	0.19	24
November, .	16,900	55	48	10m.	0.0	.03	0.0016	.0102	5.60	2.35	.0000	0.19	55
Average, .	18,400	61	52	15m.	0.0	.06	0.4951	.0237	9.49	4.16	.0169	0.36	150

Effluent of Filter No. 5C.

1906.													
December, .	48,100	61	45	1hr. 2m.	1.5	.36	2.5000	.1090	11.00	3.24	.0034	1.00	3,350
1907.													
January, . .	48,100	60	44	1hr. 7m.	0.4	.36	1.5875	.0850	11.00	4.78	.0091	0.93	8,500
February, .	50,000	60	43	1hr. 4m.	1.2	.35	0.8100	.0880	9.75	4.70	.0090	0.89	5,400
March, . .	38,500	59	43	1hr. 8m.	0.6	.35	1.4425	.0890	9.95	5.78	.0115	0.94	2,550
April, . .	48,100	58	47	7m.	0.5	.30	0.6000	.0630	11.40	7.05	.0134	0.86	2,300
May, . .	50,000	56	55	4m.	0.0	.20	0.3500	.0558	13.65	7.48	.0052	0.62	200
June, . .	44,000	62	64	3m.	0.2	.28	0.3610	.0615	16.10	7.90	.0017	0.74	2,200
July, . .	31,500	71	71	1m.	0.2	.20	0.1386	.0542	17.10	8.74	.0015	0.53	2,150
August, . .	46,300	70	72	1m.	0.3	.14	0.0350	.0375	16.15	5.29	.0021	0.40	4,700
September, .	46,000	65	69	3m.	0.3	.12	0.0052	.0346	14.55	3.62	.0001	0.39	1,650
October, . .	50,000	57	58	3m.	0.1	.08	0.0094	.0245	9.80	3.59	.0006	0.36	1,200
November, .	38,500	53	49	10m.	0.5	.09	0.0635	.0400	8.40	3.02	.0002	0.50	5,600
Average, .	44,900	61	55	24m.	0.5	.24	0.6586	.0618	12.40	5.43	.0048	0.68	3,300

Effluent of Filter No. 6.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.													
December, .	60,000	61	42	2h. 37m.	1.8	0.61	2.4200	.1220	11.90	1.14	.0021	1.25	6,000
1907.													
January, . .	57,800	61	44	4h. 1m.	0.5	0.59	2.9500	.1180	12.20	1.55	.0038	1.36	4,100
February, .	47,900	60	42	4h. 15m.	1.0	1.41	3.0900	.2040	11.00	1.46	.0045	2.12	4,500
March, . .	29,800	59	43	1h. 58m.	1.4	2.00	3.2400	.3660	11.20	1.38	.0020	4.39	7,700
April, . .	27,000	58	47	1h. 19m.	1.5	1.45	2.1750	.2840	10.90	4.16	.0028	3.11	31,800
May, . .	40,700	56	55	44m.	1.0	0.80	1.8300	.1590	14.70	4.62	.0057	1.80	3,650
June, . .	33,400	63	62	12m.	0.3	0.67	0.4000	.1225	11.45	3.20	.0026	1.26	5,100
July, . .	28,000	71	70	6m.	0.4	0.72	0.2710	.1150	8.95	4.08	.0003	0.99	9,400
August, . .	38,900	71	70	5m.	0.2	0.39	0.1503	.0530	9.40	4.45	.0003	0.66	2,650
September, .	35,300	66	69	9m.	0.0	0.27	0.0956	.0339	6.30	3.07	.0004	0.46	1,600
October, . .	40,400	56	58	13m.	0.0	0.10	0.0370	.0270	5.43	2.94	.0000	0.34	1,550
November, .	33,900	55	48	39m.	0.5	0.09	0.0895	.0270	4.70	2.86	.0022	0.41	6,800
Average, .	39,400	61	54	1h. 22m.	0.7	0.76	1.3957	.1360	9.84	2.91	.0022	1.51	7,100

Effluent of Filter No. 9A.

1906.													
December, .	60,000	62	45	2h. 40m.	1.5	0.84	2.9000	.1750	11.85	0.97	.0017	1.69	3,300
1907.													
January, .	57,800	60	46	4h. 32m.	0.5	0.60	1.9200	.1010	11.70	2.27	.0025	1.26	2,450
February, .	47,900	61	43	4h. 43m.	0.3	0.44	1.8500	.0790	11.20	3.15	.0025	0.92	1,425
March, . .	32,700	59	45	1h. 22m.	0.3	0.44	1.6975	.0910	10.70	4.20	.0018	1.00	850
April, . .	46,200	58	48	20m.	0.2	0.37	1.4125	.0700	13.40	6.13	.0014	0.89	200
May, . .	50,000	57	54	15m.	0.1	0.30	0.3052	.0514	18.90	6.30	.0008	0.56	200
June, . .	79,600	64	63	30m.	0.0	0.17	0.0157	.0342	10.85	3.87	.0000	0.40	66
July, . .	49,300	71	71	7m.	0.1	0.16	0.0070	.0342	8.55	5.04	.0009	0.42	56
August, . .	64,800	71	70	7m.	0.1	0.15	0.0031	.0189	8.25	3.40	.0001	0.28	225
September, .	61,600	65	68	16m.	0.1	0.19	0.0073	.0199	6.00	2.44	.0001	0.30	150
October, . .	70,000	56	58	32m.	0.1	0.09	0.0330	.0202	5.60	2.09	.0002	0.35	750
November, .	48,500	54	49	2h. 18m.	0.2	0.32	0.2200	.0430	5.50	1.85	.0002	0.52	3,200
Average, .	55,700	62	55	1h. 29m.	0.2	0.34	0.8643	.0615	10.21	3.48	.0010	0.72	1,100

Effluent of Filter No. 10.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.													
December, .	25,000	60	47	1h. 14m.	0.1	.15	1.3590	.0500	9.85	2.47	.0058	0.51	725
1907.													
January, . .	25,000	60	45	2h. 34m.	0.2	.35	1.0980	.0695	10.70	1.74	.0220	0.79	2,600
February, .	25,000	61	43	3h. 58m.	1.0	.63	2.0200	.1100	11.45	1.49	.0220	1.28	2,500
March, . .	16,300	59	44	1h. 18m.	0.5	.67	2.4800	.1190	8.85	1.97	.0170	1.24	750
April, . .	23,100	58	48	50m.	0.4	.33	1.6000	.0770	12.25	2.30	.0120	0.74	4,100
May, . .	25,000	57	54	1h. 52m.	0.6	.38	0.8175	.0850	15.70	1.97	.0086	0.86	1,325
June, . .	51,200	63	65	2h. 5m.	0.4	.40	0.2513	.0740	12.95	1.89	.0018	0.89	1,100
July, . .	26,700	71	68	53m.	0.4	.60	0.1010	.0750	8.75	1.51	.0011	0.88	775
August, . .	26,700	70	70	1h. 3m.	0.4	.64	0.1618	.0623	8.95	2.61	.0020	0.97	500
September, .	38,400	66	69	6m.	0.2	.29	0.1815	.0535	6.15	2.15	.0006	0.47	300
October, . .	40,000	55	58	10m.	0.1	.09	0.0876	.0214	5.45	2.28	.0008	0.54	175
November, .	30,800	55	50	18m.	2.0	.09	0.2420	.0330	5.20	2.35	.0002	0.44	7,900
Average, .	29,400	61	55	1h. 22m.	0.5	.38	0.8666	.0691	9.69	2.06	.0078	0.80	1,900

Filters Nos. 305 and 306.

These two filters, semicircular in shape, and of an approximate area of 1/400 of an acre, were started Aug. 24, 1906. Each contains 54 inches of sand of an effective size of 0.27 millimeter. Both filters have been operated at the rate of 50,000 gallons per acre daily throughout the year, Filter No. 305 receiving the strong station sewage, and Filter No. 306 receiving sewage diluted with canal water. From March 18 to April 3 inclusive the filters were flooded only three times a week.

From Dec. 1, 1906, to March 12, 1907, the surface of the filters was trenched and the trenches covered with boards. On April 6 the trenches were dug over to a depth of 3 inches, the surfaces of the filters levelled and dug over to a depth of 8 inches. On July 13 the surface of both filters was dug over to a depth of 3 inches, and on November 20 they were trenched for the winter.

The trenches were raked 1 inch deep once in December, twice in January, once in February, once in March and once in November, and the whole of the filters was raked once each week while the surface was level.

Snow, averaging 2 inches in depth, was removed from the trenches on three different dates after the board covers were removed. The filters were rested April 1 to April 3, July 8 to July 14 and November 8 to November 10, inclusive.

Effluent of Filter No. 305.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS—		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.													
December, .	55,400	61	45	30m.	.1	.09	2.1625	.0660	12.20	3.15	.0050	.46	1,200
1907.													
January, . .	55,600	60	45	1h. 6m.	.1	.05	1.2850	.0540	11.00	3.82	.0059	.52	2,350
February, .	60,000	60	43	43m.	.2	.13	1.4875	.0600	9.55	5.06	.0130	.49	4,200
March, . .	43,800	60	43	1h. 9m.	.4	.14	0.6420	.0582	11.35	5.49	.0100	.53	1,625
April, . .	55,400	58	48	7m.	.1	.08	0.4900	.0410	11.95	5.33	.0062	.44	3,600
May, . .	57,800	56	55	2m.	.1	.06	0.1083	.0370	13.75	6.01	.0022	.36	1,800
June, . .	27,600	62	63	2m.	.1	.08	0.2470	.0520	15.75	6.88	.0094	.33	1,875
July, . .	18,900	71	73	1m.	.0	.06	0.2725	.0430	16.45	5.88	.0039	.30	1,825
August, . .	55,600	70	71	1m.	.0	.07	0.0681	.0249	16.95	4.87	.0005	.28	775
September, .	55,200	65	68	3m.	.1	.04	0.0261	.0191	14.55	3.66	.0011	.19	150
October, . .	55,600	55	57	2m.	.1	.05	0.0143	.0140	10.75	3.24	.0012	.17	150
November, .	46,200	54	49	15m.	.1	.04	0.2360	.0270	9.00	3.11	.0048	.25	300
Average, .	48,900	61	55	20m.	.1	.07	0.5866	.0414	12.77	4.71	.0053	.36	1,700

Effluent of Filter No. 306.

1906.													
December, .	57,700	60	45	29m.	.1	.07	0.8100	.0480	6.20	2.02	.0039	.26	500
1907.													
January, .	60,100	60	45	42m.	.0	.03	0.3320	.0255	5.80	2.36	.0016	.29	875
February, .	60,000	60	43	1h. 18m.	.1	.05	0.1986	.0154	4.05	2.02	.0015	.15	325
March, . .	41,600	59	42	55m.	.0	.05	0.1116	.0210	3.50	2.63	.0018	.27	400
April, . .	55,400	58	48	5m.	.0	.03	0.1108	.0195	4.35	2.94	.0045	.21	2,300
May, . .	57,800	57	55	1m.	.1	.06	0.0640	.0213	4.75	2.44	.0006	.20	160
June, . .	26,400	62	64	1m.	.1	.05	0.1084	.0228	5.85	2.81	.0041	.20	650
July, . .	20,000	72	72	1m.	.1	.03	0.0504	.0184	6.80	2.40	.0010	.13	2,900
August, . .	55,600	71	71	1m.	.1	.05	0.0173	.0119	6.80	2.48	.0001	.10	625
September, .	57,600	65	68	2m.	.0	.03	0.0019	.0092	6.05	1.81	.0000	.09	70
October, . .	55,600	56	58	1m.	.0	.03	0.0070	.0068	4.10	1.33	.0013	.07	75
November, .	46,200	54	48	9m.	.0	.03	0.0624	.0100	4.60	1.93	.0060	.20	100
Average, .	49,500	61	55	19m.	.0	.04	0.1562	.0192	5.24	2.21	.0022	.18	750

OPERATION OF CONTACT FILTERS.

During 1907 five contact filters were in operation at the station, namely, Filters Nos. 175, 176, 221, 237 and 251.

Filters Nos. 175 and 176.

Filters Nos. 175 and 176, first put into operation June 3, 1901, were continued during 1907. Each filter is 5 feet in depth, and is constructed of pieces of coke of such size that all will pass through a sieve having a 1-inch mesh, 75 per cent. through a ½-inch mesh, and practically none through a sieve with a ¼-inch mesh. Filter No. 175 has always received sewage that has passed through a coke or coal strainer, and Filter No. 176 has received settled sewage throughout the year. Each of these filters was allowed to rest every sixth week. During the year Filter No. 175 was operated at an average rate of 431,900 gallons per acre daily, and Filter No. 176 at an average rate of 357,500 gallons per acre daily. At the end of the year Filter No. 175 contained 33 per cent. of open space, and Filter No. 176 contained 28 per cent., — a loss of 44 per cent. and 52 per cent., respectively, during the six and one-half years of their operation. No appreciable reduction of open space was noted during the year.

Filter No. 221.

Filter No. 221 is ⅕₀₀₀ of an acre in area, and is constructed of 42 inches of broken stone of such a grade that all pieces will pass through a sieve with a 1-inch mesh, 25 per cent. through a ½-inch mesh, but none through a sieve with a ¼-inch mesh. The underdrains of this filter are constructed of 6 inches of cobblestones laid upon brick channels. This filter was put into operation July 7, 1903, and during 1907 was operated with settled sewage at an average rate of 350,000 gallons per acre daily.

The filter was operated without rest until July 8, after which it was rested every sixth week. On July 8, after being in operation four years, the filter contained only about one-fourth as much open space as at the start. Systematic resting of the filter during the last five months of the year has eliminated much of the clogging material, and at the end of the year the open space had increased to about 50 per cent. of what it was when the filter was first started.

Filter No. 237.

Filter No. 237, $\frac{1}{20000}$ of an acre in area, constructed of 60 inches of clinker varying in size from ¾ to 1¾ inches in diameter, laid over brick underdrains, was first put into operation Jan. 1, 1904, and has received the effluent from Filter No. 221 since that time, being flooded twice daily. The average rate of filtration during 1907 was 1,401,000 gallons per acre daily.

From Dec. 1, 1906, to July 7, 1907, the filter was operated six days a week without rest, and was rested every sixth week after July 8. During the earlier portion of the year the open space in the filter was about 25 per cent. less than at the time the filter was started. The systematic resting resulted in the elimination of practically all of the clogging material, the open space at the end of the year being substantially the same as when the filter was new.

Filter No. 251.

Filter No. 251, $1/10000$ of an acre in area, and constructed of 28 inches of Pennsylvania coke of such size that all the pieces will pass through a sieve with a $1/2$-inch mesh, and practically none through a sieve with a $1/8$-inch mesh, was first put into operation Aug. 1, 1904, and has been flooded since that time with the effluent from Septic Tank A. The average rate of filtration during the year was 609,000 gallons per acre daily. The filter was operated six days a week without rest until July 8, after which time it was rested every sixth week. The material in this filter contained 67 per cent. of voids at the start, but on July 15, 1907, after being in operation about three years, the open space had been reduced to 40 per cent. Systematic resting improved the condition of the filter somewhat, and at the end of the year the open space had increased to 44 per cent.

Average Sewage applied to Filter No. 175.

[Parts per 100,000.]

DATE.	AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	Oxygen Consumed.
		ALBUMINOID.					
	Free.	Total.	In Solution.	Total.	In Solution.		
December, 1906, to November, 1907, inclusive, .	4.26	.63	.42	1.13	.74	14.45	4.13

Average Sewage applied to Filter No. 237.

December, 1906, to November, 1907, inclusive, .	2.96	.34	.22	0.60	.40	14.70	2.73

Average Sewage applied to Filter No. 251.

December, 1906, to November, 1907, inclusive, .	4.64	.50	.33	0.83	.56	13.43	3.89

Effluent of Filter No. 175.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.) Sewage.	APPEARANCE.		AMMONIA.			Kjeldahl Nitrogen.	Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Turbidity.	Color.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
						Total.	In Solution.						
Dec. 1906, to Nov. 1907, inclusive, .	431,900	52	4.5	0.78	1.3558	.3167	.2245	.6060	14.06	2.01	.0207	2.19	316,300

Effluent of Filter No. 176.

Dec. 1906, to Nov. 1907, inclusive, .	357,500	58	5.1	1.02	1.5933	.3005	.2243	.5519	14.32	0.30	.0054	2.40	194,600

Effluent of Filter No. 221.

Dec. 1906, to Nov. 1907, inclusive, .	350,500	58	7.0	0.94	3.2469	.3580	.2562	.6440	14.33	0.14	.0069	2.75	414,200

Effluent of Filter No. 237.

Dec. 1906, to Nov. 1907, inclusive, .	1,401,100	58	5.2	0.72	1.2950	.3663	.1830	.6440	14.40	1.94	.0317	2.49	208,300

Effluent of Filter No. 251.

Dec. 1906, to Nov. 1907, inclusive, .	608,700	62	6.5	0.82	2.4667	.4275	.2918	.7848	13.57	1.24	.0164	3.16	482,100

Average Solids in Effluent of Filter No. 176.

[Parts per 100,000.]

UNFILTERED.			FILTERED.			IN SUSPENSION.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
61.1	12.0	49.1	58.5	9.4	49.1	2.6	2.6	0.0

Average Solids in Effluent of Filter No. 221.

57.5	13.0	44.5	54.0	10.2	43.8	3.5	2.8	0.7

Summary of Putrescibility Tests on Effluents from Contact Filters.

1907.	Number of Samples tested.	Per Cent. of Samples putrefying.		
		Unsettled.	After settling Three Hours.	Mixed with 50 Per Cent. of City Water.
Filter No. 175,	9	0	0	0
Filter No. 176,	11	55	55	0
Filter No. 221,	9	100	100	44
Filter No. 237,	10	0	0	0
Filter No. 251,	9	33	22	0

Trickling, Sprinkling or Percolating Filters.

During 1907 six sprinkling filters were in operation, four of which were constructed of broken stone and two of clinker. Two of these filters, namely, Nos. 135 and 136, have been in operation since November, 1899.

Filters Nos. 135 and 136.

Filters Nos. 135 and 136 were first put into operation on Nov. 28, 1899. Each of these filters is 10½ feet in depth, and constructed of broken stone, all of which will pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a ½-inch mesh and 4 per cent. through a screen with a ¼-inch mesh. Sewage is distributed over the surface of these filters, as over all other trickling or sprinkling filters at the station, by means of automatic tipping basins placed in perforated pans. The spreader pan on Filter No. 135 was placed directly on the surface throughout the year, while that on Filter No. 136 was on the surface from Dec. 1, 1906, to May 3, 1907, and 16 inches above it the remainder of the year. Settled sewage was applied to both filters throughout the year, Filter No. 135 being operated at the rate of 1,500,000 gallons per acre daily from Dec. 1, 1906, to Dec. 16, 1906, inclusive; of 2,000,000 gallons from December 17 to July 7 and of 1,500,000 gallons from July 8 to November 30. Filter No. 136 was operated at the rate of 2,500,000 gallons per acre daily from Dec. 1, 1906, to Dec. 16, 1906, of 4,000,000 gallons from December 17 to April 28, of 3,000,000 gallons from April 29 to July 7 and of 2,000,000 gallons from July 8 to November 30.

On January 11 the surface of Filter No. 136 became clogged with a growth of small white worms or maggots, and was rested until January 28. This treatment relieved the clogging somewhat, and the filter was operated until April 12, when the clogging had become so serious that the filter was again rested for two weeks. After resting, the filter still failed to pass sewage freely, and on April 29 the upper 6 inches of stone was removed, washed and replaced. No further clogging was experienced with this filter during the remainder of the year, nor was any similar clogging noted in Filter No. 135. Both filters were rested from July 1 to July 7, inclusive.

Filters Nos. 233 and 235.

Filters Nos. 233 and 235, constructed of 69 inches of clinker, were first put into operation on Jan. 1, 1904. The pieces of clinker in Filter No. 233 vary in size from ¾ of an inch to 1¾ inches in diameter, while in Filter No. 235 they vary from ¼ inch to ¾ inch. Both filters were operated with settled sewage at the rate of 1,500,000 gallons per acre daily from December 1 to June 30, and of 1,000,000 gallons from July 1 to November 30.

The filters were rested from July 8 to 14, inclusive. No difficulty was experienced in operating these two filters at the above rates, and the effluents continued to be of satisfactory quality, although nitrification was much more active in the filter constructed of fine material.

Filters Nos. 247 and 248.

Filters Nos. 247 and 248 are constructed of the same grade of material as Filters Nos. 135 and 136, and were first put into operation May 16, 1904, Filter No. 247 containing about 5 feet and Filter No. 248 about 8 feet of material.

Both filters were operated with settled sewage throughout the year, at an approximate rate of 2,000,000 gallons per acre daily. Both filters rested from July 8 to July 14, inclusive. Nitrification was much more active in the 8-foot filter, and the effluent was generally of better quality than that of the 5-foot filter.

Filter No. 222 (Andover).

Filter No. 222 is $1/200$ of an acre in area, and is located in Andover. After rebuilding in April, 1906, the filter consisted of 6 inches of cobblestones above Akron pipe underdrains, overlaid with 7 feet of No. 2 broken stone. The depth of filtering material is greater than the depth of the tank, and the upper 2 feet of material are held in place by a stone wall. A description of the method of applying sewage to this filter by means of an automatic flush tank and dash plates was contained in the report for 1906 (page 268). The filter was operated from Dec. 1, 1906, to June 13, 1907, at an average rate of 1,350,000 gallons per acre per day. But little trouble was experienced in operating the filter during the cold weather. On December 19, after a period of extremely cold weather, during which the thermometer reached 29° below zero, no frost was found in that portion of the surface of the filter which was wet by the sewage. There were clear circles about each orifice approximately 5 feet in diameter, between these circles there being a layer of ice and frozen snow about 8 inches deep, covering the portion of the filter not wet. On January 12 the surface of the filter became badly clogged with a growth of bacterial zoöglea, and the filter was dug over to a depth of 4 to 6 inches. On January 17, owing to the clogging of some of the orifices with organic matter, the distribution pipes became frozen and flow of sewage was interrupted. On April 17 the surface of the filter again became clogged, and was dug over to a depth of 3 inches. On June 12 the filter again became clogged, and it was evident that the clogging was not upon the surface alone, as only a part of the applied sewage reached the effluent pipe. The filter was rested from June 15 to 24, inclusive. From June 25 to July 5 copper sulphate was mixed with the applied sewage in the proportion of one part per million. This treatment effectually removed the surface clogging but did not relieve subsurface clogging, and the filter was again rested from July 6 to 15, inclusive. On July 16 the filter was again started, but on July 19, however, the effluent was finding its way through the sides of the filter, and from July 19 to August 6 sewage was applied for four hours per day only, the average rate of the filter during this period being about 98,000 gallons per acre daily, all of the sewage applied coming through the effluent pipe. From August 7 to 14 sewage was applied for eight hours daily, the average rate during this period being 150,000 gallons per acre daily. From August 14 to September 4 sewage was applied for twenty-four hours daily, but at a very low rate, the average rate of the filter being 77,000 gallons per acre daily. From September 4 to October 31 a number of changes in the method of operating were made, but notwithstanding the fact that sewage was applied for only a few hours per day, and at rates less than 50,000 gallons per acre per day, only a portion of the applied sewage found its way through the effluent pipes. As it was evident that subsurface clogging of a serious nature existed, operation of the filter was discontinued on October 31. The inadequate nitrification during the greater portion of the year, together with the freedom of the effluent from turbidity, showed that there must have been a very considerable accumulation of organic matter within the filtering material, and on examination it was found that the clogging was due in part to a broken underdrain pipe and in part to the fact that the material was a mixture of fine and coarse stone.

Effluent of Filter No. 135.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Seven Days in a Week.	Temperature (Deg. F.) Sewage.	APPEARANCE.		AMMONIA.			Kjeldahl Nitrogen.	Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
						ALBUMINOID.							
			Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
1906.													
December, .	2,039,000	55	4.0	.70	0.90	.43	.17	0.81	12.20	3.95	.0030	3.28	39,000
1907.													
January, .	1,957,000	55	4.0	.60	0.68	.63	.24	1.13	13.00	5.71	.0020	4.76	18,300
February, .	1,986,000	52	3.0	.55	1.13	.65	.18	0.92	12.20	4.36	.0060	3.34	47,800
March, . .	1,946,000	53	3.0	.65	0.60	.41	.15	0.88	11.60	5.03	.0060	3.29	6,300
April, . .	1,920,000	53	7.0	.65	1.13	.42	.28	0.79	13.80	4.95	.0090	3.39	14,500
May, . .	1,903,000	57	5.0	.60	1.18	.40	.22	0.70	16.70	3.53	.0070	3.14	13,500
June, . .	1,871,000	64	3.5	.40	0.83	.29	.08	0.50	18.20	5.63	.0040	1.90	5,750
July, . .	1,003,000	70	4.0	.60	1.28	.20	.13	0.37	18.60	5.70	.0080	1.71	67,500
August, . .	1,435,500	69	4.0	.75	0.84	.17	.13	0.41	15.00	3.61	.0060	1.67	55,300
September, .	1,490,000	64	2.0	.50	0.60	.18	.14	0.42	14.20	4.20	.0060	2.31	29,000
October, .	1,497,000	51	–	.60	0.95	.19	.12	0.38	13.90	3.60	.0110	1.87	15,500
November, .	1,450,000	51	1.0	.65	1.10	.28	.18	0.48	11.40	3.19	.0050	2.71	40,300
Average, .	1,708,100	58	3.7	.60	0.93	.35	.17	0.65	14.23	4.46	.0061	2.78	29,400

Effluent of Filter No. 136.

1906.													
December, .	3,746,000	55	5.0	.80	1.60	.57	.26	0.87	12.20	3.11	.0040	4.10	33,500
1907.													
January, .	1,781,000	55	6.0	.60	2.35	.82	.48	1.37	13.40	3.11	.0060	5.64	20,500
February, .	3,804,000	52	6.0	.85	3.15	.57	.35	1.00	12.10	1.59	.0070	3.59	175,000
March, . .	3,794,000	53	4.0	.80	2.35	.71	.32	1.27	11.20	3.52	.0080	4.64	19,800
April, . .	1,583,000	53	10.0	.65	2.75	.69	.42	1.25	12.40	1.84	.0120	5.39	24,500
May, . .	2,913,000	57	10.0	.70	4.70	.69	.49	1.35	17.10	2.33	.0210	5.38	123,500
June, . .	2,886,000	64	8.0	.55	2.35	.50	.30	0.77	18.50	3.43	.0120	4.11	28,000
July, . .	1,290,000	70	6.0	.65	1.65	.33	.28	0.51	19.60	4.78	.0100	1.99	72,500
August, . .	1,887,000	69	4.0	.75	1.15	.25	.20	0.43	15.10	1.76	.0030	1.72	30,500
September, .	1,914,000	64	2.0	.55	0.90	.30	.22	0.44	14.60	4.37	.0040	2.80	13,800
October, . .	1,952,000	51	–	.60	0.88	.25	.22	0.46	13.90	3.35	.0090	2.23	43,800
November, .	1,900,000	51	3.0	.80	1.60	.33	.23	0.56	11.30	2.86	.0030	3.08	79,500
Average, .	2,454,200	58	5.8	.69	2.12	.50	.31	0.86	14.28	3.00	.0083	3.72	55,400

Yearly Averages (December, 1906, to November, 1907, Inclusive).

Effluent of Filter No. 233.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.) Sewage.	APPEARANCE.		AMMONIA.			Kjeldahl Nitrogen.	Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
					ALBUMINOID.							
		Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
1,205,200	58	6.0	.79	2.89	.49	.29	0.89	14.32	0.97	.0062	3.22	212,400

Effluent of Filter No. 235.

1,236,800	58	4.4	.75	1.62	.48	.19	0.81	14.39	2.60	.0098	3.39	125,200

Effluent of Filter No. 247.

1,901,500	58	7.4	.87	3.79	.65	.35	1.18	14.61	0.84	.0156	4.51	148,200

Effluent of Filter No. 248.

1,889,300	58	6.1	.78	2.24	.60	.27	1.03	14.48	2.08	.0155	3.74	54,700

Average Solids in Effluent of Filter No. 136.

[Parts per 100,000.]

UNFILTERED.			FILTERED.			IN SUSPENSION.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
74.6	23.2	51.4	62.5	16.0	46.5	12.1	7.2	4.9

Average Solids in Effluent of Filter No. 233.

63.0	17.7	45.3	52.6	10.6	42.0	10.4	7.1	3.3

Andover Settled Sewage.

[Parts per 100,000.]

DATE.	Temperature (Deg. F.)	AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Free.	ALBUMINOID. Total.	ALBUMINOID. In Solution.	Total.	In Solution.			
1906.									
December,	–	1.38	.28	.17	0.50	0.31	3.33	1.70	–
1907.									
January,	–	1.05	.22	.11	0.40	0.22	3.50	1.34	–
February,	–	4.65	.77	.57	1.79	1.24	7.15	6.95	–
March,	–	3.15	.54	.37	1.16	0.69	4.75	4.30	–
April,	43	1.70	.40	.27	1.09	0.76	4.02	3.35	–
May,	50	1.98	.46	.34	0.91	0.67	6.00	3.53	–
June,	53	3.40	.48	.31	0.92	0.54	6.10	4.12	–
July,	61	3.17	.47	.31	0.84	0.59	10.60	3.07	–
August,	63	3.41	.52	.40	1.00	0.66	9.76	3.02	–
September,	63	3.90	.66	.47	1.30	0.89	9.38	5.35	–
October,	–	2.74	.42	.31	1.00	0.71	7.32	3.75	625,000
Average,	56	2.78	.47	.33	0.99	0.66	6.54	3.68	–

Average Solids in Andover Settled Sewage.

[Parts per 100,000.]

	UNFILTERED.			FILTERED.			IN SUSPENSION.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
1906.									
December,	23.7	9.2	14.5	21.1	6.9	14.2	2.6	2.3	0.3
1907.									
January,	20.9	6.8	14.1	16.5	4.1	12.4	4.4	2.7	1.7
February,	65.2	36.8	28.4	47.9	20.6	27.3	17.3	16.2	1.1
March,	41.1	19.8	21.3	33.1	12.7	20.4	8.0	7.1	0.9
April,	33.1	14.3	18.8	26.8	8.9	17.9	6.3	5.4	0.9
May,	40.6	20.3	20.3	37.3	17.3	20.0	3.3	3.0	0.3
June,	43.8	20.5	23.3	35.9	13.7	22.2	7.9	6.8	1.1
July,	49.6	16.6	33.0	44.7	15.2	29.5	4.9	1.4	3.5
August,	45.0	16.7	28.3	40.9	13.4	27.5	4.1	3.3	0.8
September,	58.0	27.6	30.4	47.2	18.1	29.1	9.8	9.5	0.3
October,	40.6	15.8	24.8	38.0	13.3	24.7	2.6	2.5	0.1
Average,	42.0	18.6	23.4	35.4	13.1	22.3	6.6	5.5	1.1

Effluent of Filter No. 222.

[Parts per 100,000.]

Date.	Quantity Applied. Gallons per Acre Daily for Seven Days in a Week.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as—		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).
		Turbidity.	Color.	Free.	Albuminoid.				Nitrates.	Nitrites.		
					Total.	In Solution.						
1906.												
December,	1,300,000	0.3	.48	2.3950	.1428	.1253	.2351	5.20	.07	.0042	1.03	9.9
1907.												
January,	1,360,000	0.2	.36	1.5100	.1070	.0784	.1653	3.55	.05	.0034	0.71	5.8
February,	1,250,000	1.8	.58	4.1188	.3250	.2840	.6711	6.45	.03	.0000	2.46	0.0
March,	1,310,000	2.5	.49	3.3513	.2745	.2260	.4724	4.80	.01	.0000	1.84	1.6
April,	1,460,000	1.1	.35	1.6860	.1312	.1000	.2497	3.26	.01	.0005	1.10	8.7
May,	1,450,000	1.1	.37	2.1110	.1668	.1380	.2989	4.60	.01	.0020	1.37	7.5
June,	1,450,000	1.2	.38	3.1833	.1983	.1780	.3397	5.90	.01	.0000	1.54	2.5
July,	510,000	1.3	.53	4.1083	.2917	.2493	.4270	8.63	.00	.0003	1.54	5.0
August,	62,000	0.6	.54	4.0660	.1808	.1372	.3087	9.20	.02	.0010	1.25	24.5
September,	68,000	0.3	.52	2.6200	.1860	.1605	.3072	8.43	.01	.0001	1.38	18.0
October,	34,000	0.4	.53	2.3340	.0948	.0848	.1541	4.84	.01	.0010	0.76	50.8
Average,	932,200	1.0	.47	2.8622	.1908	.1601	.3299	5.90	.02	.0011	1.36	12.2

Summary of Putrescibility Tests on Effluents from Trickling Filters.

1907.	Number of Samples tested.	Per Cent. of Samples putrefying.		
		Unsettled.	After settling Three Hours.	Mixed with 50 Per Cent. of City Water.
Filter No. 135,	11	0	0	0
Filter No. 136,	10	0	0	0
Filter No. 222,	8	12	0	0
Filter No. 233,	10	9	0	0
Filter No. 235,	10	0	0	0
Filter No. 247,	10	50	30	10
Filter No. 248,	10	0	0	0

REFILTRATION OF TRICKLING FILTER EFFLUENTS.

Three sand filters, namely, Nos. 224, 249 and 250, were operated with the settled effluents of Filters Nos. 135 and 136.

Filter No. 224.

Filter No. 224, $\frac{1}{20000}$ of an acre in area, was first put into operation on Oct. 1, 1903, and contained about 36 inches of sand of an effective size of 0.27 millimeter during the greater portion of the year 1907. It received the effluents of Filters Nos. 135 and 136 after they had passed through a settling basin, at an average rate, during 1907, of 503,000 gallons per acre daily. The surface of the filter was raked to a depth of 3 inches once each week during the year, and on January 9, January 27, February 8, May 7 and November 30 the surface was dug over to a depth of 6 inches. On February 16, 6 inches of clogged sand were removed from the surface of the filter. The filter was allowed to rest from Dec. 22, 1906, to Jan. 9, 1907, from February 2 to February 8, from February 14 to February 18 and from June 29 to July 7, inclusive. In spite of these various treatments, it was very difficult to maintain the high prescribed rate of filtration, owing to the accumulation of organic matter in the upper layers of the sand.

Filters Nos. 249 and 250.

Filters Nos. 249 and 250, each $\frac{1}{20000}$ of an acre in area, and constructed of sand of an effective size of 0.41 millimeter, were first put into operation May 16, 1904, and have received since that time the effluents of Filters Nos. 135 and 136 after passing through a sedimentation basin. The average rate of operation during 1907 was 630,000 gallons per acre daily for Filter No. 249 and 576,000 gallons per acre daily for Filter No. 250. As stated in previous reports, these two filters, besides being used as a study in secondary filtration, are also intended to give information with regard to sand removal. It has been the practice never to dig over Filter No. 249 to a greater depth than 3 inches, and when these upper 3 inches of sand become so clogged with organic matter that sewage will not pass through it, they are removed. On the other hand, Filter No. 250 has been dug over to a greater depth when necessary, and has been operated as long as possible without removing any sand from the surface. During 1907 both filters were raked to a depth of 3 inches each week. Three inches of sand were removed from Filter No. 249 on January 9, February 9 and July 7, the total depth of sand in the filter at the end of the year being about 40 inches. Filter No. 249 was allowed to rest December 19 to 21, December 28 to January 9, April 12 to 27, June 17 to 23, June 26 to July 7 and November 12 to 14, inclusive. Filter No. 250 was dug over 6 inches deep on December 6, 9 inches deep on December 12, 12 inches deep on December 13, 15 inches deep on December 17. This deep digging allowed the filter to be operated until December 27, when the surface again became clogged. The filter was rested December 28 to January 9, inclusive, and after digging to a depth of 6 inches, settled sprinkling filter effluents were again applied. On February 1 the surface clogging had become so serious that the filter was allowed to rest until February 9, and 6 inches of sand were removed from the surface. The surface of the filter was also dug over 6 inches deep on March 19, May 22, June 3, June 22, July 7 and October 21, and the filter was allowed to rest March 14 to 21, April 13 to 27, June 15 to 23, June 26 to July 7, October 21 to 28 and November 12 to 14, inclusive. At the end of the year the depth of sand in the filter was about 60 inches, the deep digging of the filter having loosened the sand, so that, notwithstanding removals, the depth of the filter remained practically unchanged.

Effluent applied to Filters Nos. 224, 249 and 250.

[Parts per 100,000.]

Date.	Temperature (Deg. F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
					Albuminoid.						
		Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
1906.											
December,	54	3.5	.80	2.8150	.2240	.1370	11.55	1.49	.0225	1.87	30,800
1907.											
January,	52	5.0	.80	2.8400	.3180	.1780	14.45	1.78	.0310	2.41	147,000
February,	45	3.0	.80	3.1500	.2160	.1800	8.90	0.99	.0180	1.48	80,000
March,	55	4.3	.70	3.4750	.2040	.1640	13.30	1.00	.0370	1.42	49,800
April,	60	10.0	.85	3.0000	.3480	.1980	13.40	5.65	.0560	2.50	100,000
May,	60	4.5	.75	2.5800	.2540	.1460	16.30	1.22	.0460	1.91	94,000
June,	64	4.0	.78	2.6600	.2560	.1280	19.15	2.13	.0760	2.09	301,500
July,	71	5.5	.68	2.1200	.2360	.1270	15.40	2.45	.0490	1.36	425,000
August,	68	2.5	.68	1.3400	.1680	.1210	17.20	2.09	.0340	1.29	360,000
September,	63	1.0	.60	0.6000	.1040	.0880	16.30	2.62	.0240	1.24	82,000
October,	58	3.3	.60	1.5000	.1280	.1090	12.40	1.84	.0330	1.41	145,800
November,	54	1.5	.70	1.8800	.1440	.1020	9.90	1.93	.0480	1.57	31,000
Average,	59	4.0	.73	2.3300	.2167	.1398	14.02	2.10	.0395	1.71	153,900

Effluent of Filter No. 224.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS—		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.												
December, .	430,800	54	55	0.1	0.79	0.84	.12	11.75	2.33	.0007	1.45	470
1907.												
January, . .	378,000	52	52	0.2	0.40	0.72	.07	14.45	3.71	.0650	0.65	3,100
February, . .	408,000	45	44	0.1	0.27	0.27	.08	9.00	1.97	.0550	0.63	1,700
March, . .	585,000	55	59	0.4	0.28	0.74	.07	13.35	3.73	.0090	0.71	290
April, . .	531,000	60	60	0.3	0.32	0.23	.06	17.00	3.44	.0121	0.67	380
May, . . .	563,000	60	62	0.4	0.23	0.12	.07	17.15	3.03	.0011	0.55	185
June, . . .	560,000	64	65	0.0	0.21	0.18	.05	17.98	4.03	.0004	0.46	70
July, . . .	422,000	71	71	0.2	0.22	0.33	.06	15.70	3.91	.0006	0.54	1,800
August, . .	570,400	68	69	0.1	0.22	0.06	.04	17.40	3.19	.0004	0.49	775
September, .	592,000	63	64	0.1	0.22	0.02	.04	16.20	3.47	.0000	0.58	2,800
October, . .	600,000	58	61	0.1	0.25	0.24	.04	13.58	2.98	.0005	0.58	2,500
November, .	400,000	54	53	0.3	0.42	0.14	.06	9.20	3.11	.0002	0.35	1,000
Average, .	503,400	59	60	0.2	0.32	0.32	.06	14.40	3.24	.0121	0.64	1,300

Effluent of Filter No. 249.

1906.												
December, .	623,000	54	52	0.2	0.51	1.67	.09	12.25	4.71	.2100	0.98	2,250
1907.												
January, . .	459,000	52	53	0.4	0.30	0.13	.07	14.50	3.78	.0011	0.64	9,900
February, . .	733,000	45	44	0.2	0.15	0.38	.05	8.80	4.52	.0240	0.47	1,900
March, . .	608,000	55	55	0.4	0.31	1.08	.07	13.00	5.13	.0013	0.80	450
April, . .	431,000	60	61	1.0	0.34	0.20	.08	15.20	3.95	.0002	0.76	6,800
May, . . .	800,000	60	61	0.7	0.33	0.21	.07	17.20	4.24	.0017	0.66	1,300
June, . .	408,000	64	70	0.4	1.13	1.11	.14	17.95	3.10	.0140	1.15	3,500
July, . . .	563,000	71	70	0.4	0.16	0.08	.05	15.95	5.00	.0009	0.38	27,200
August, . .	748,000	68	69	0.4	0.26	0.07	.05	17.95	3.07	.0002	0.46	3,650
September, .	752,000	63	64	0.2	0.30	0.05	.06	16.10	3.63	.0002	0.59	2,150
October, . .	793,000	58	58	0.5	0.38	0.25	.06	12.80	3.82	.0004	0.75	5,000
November, .	646,200	54	55	0.8	0.46	0.11	.06	8.60	3.19	.0002	0.72	1,400
Average, .	630,400	59	59	0.5	0.39	0.44	.07	14.19	4.01	.0212	0.70	5,500

Effluent of Filter No. 250.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS—		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.												
December, .	612,000	54	52	0.4	0.40	1.09	.11	12.20	2.97	.0088	1.19	2,400
1907.												
January, . .	474,000	52	53	0.4	0.40	0.63	.09	14.45	3.65	.2200	0.76	3,600
February, . .	567,000	45	44	0.2	0.22	0.39	.06	8.60	4.88	.0080	0.60	2,000
March, . .	446,000	55	55	0.6	0.64	1.33	.11	13.10	2.89	.0525	1.12	2,900
April, . .	388,000	60	61	1.5	0.50	0.48	.12	14.20	5.71	.0032	1.02	10,500
May, . . .	719,000	60	61	1.1	0.59	0.33	.10	17.50	2.73	.1690	0.92	4,450
June, . . .	398,000	64	65	0.5	0.81	0.55	.11	18.40	3.35	.1410	1.09	5,800
July, . . .	563,000	71	70	0.4	0.18	0.05	.05	16.05	5.46	.0002	0.46	6,300
August, . .	748,000	68	69	0.3	0.28	0.07	.05	17.65	3.57	.0002	0.50	4,400
September, .	752,000	63	64	0.1	0.28	0.01	.05	16.20	3.40	.0002	0.58	600
October, . .	600,000	58	60	0.1	0.35	0.58	.06	14.45	3.82	.0410	0.69	24,600
November, .	646,200	54	54	1.0	0.45	0.07	.07	8.70	2.77	.0010	0.82	3,850
Average, .	576,100	59	59	0.5	0.43	0.46	.08	14.29	3.77	.0538	0.81	6,000

MECHANICAL FILTRATION OF EFFLUENTS OF SPRINKLING FILTERS.

Filter No. 300.

This filter was started in April, 1906, to study the efficiency of coagulation with chemicals, followed by filtration at a high rate, on the effluents from sprinkling filters, and was continued in operation during the first five months of 1907. This filter, $1/80000$ of an acre in area, and containing 24 inches of sand of an effective size of 0.35 millimeter, was operated at a rate of 50,000,000 gallons per acre daily with the mixed settled effluents from Filters Nos. 135, 136, 233, 235, 247 and 248, after treatment with copperas and lime and sedimentation of about two and one-half hours. About eight grains of copperas and ten grains of lime per gallon of water filtered were required to produce a clear effluent, and it was necessary to wash the filter at intervals of about four hours. The average quantity of water filtered between washings was only about 10,000,000 gallons per acre daily. The considerable expense for chemicals, $10.30 per million gallons, and the small quantity of water filtered between washings, together with the poor bacterial removal, shows that, with copperas and lime as coagulants, such a system has small value among sewage-disposal schemes. A few runs made in May indicated that, with sulphate of alumina instead of copperas and lime as a coagulant, as good an effluent could be produced at less than half the cost, and that the amount of water filtered between washings was about doubled. The average chemical and bacterial analyses and the efficiency of the filter in removing bacteria and organic matter during the time copperas and lime were used are shown in the following tables: —

Average Chemical Analyses of Effluents of Filters Nos. 135 and 136 applied to Filter No. 300, and Effluent of Filter No. 300.

Settled Trickling Filter Effluents applied to Filter No. 300.

[Parts per 100,000.]

Temperature (Deg. F.).	Appearance.			Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Iron.	Free Carbonic Acid.
					Albuminoid.							
	Turbidity.	Sediment.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
57	3.1	0.1	.81	3.7635	.3247	.2118	12.65	.35	.0269	2.40	.6596	3.3

Effluent of Filter No. 300.

55	0.3	0.0	.59	3.7109	.1355	-	11.13	.05	.0558	0.93	.1320	—0.3

Average of Bacterial Analyses. — Filter No. 300.

Average Bacteria per Cubic Centimeter.			Average B. Coli per Cubic Centimeter.		
Applied Effluents.	Effluent from Coagulation Basin.	Effluent from Filter.	Effluents of Filters Nos. 135 and 136.	Effluent from Coagulation Basin.	Effluent from Filter.
650,000	135,000	73,300	15,600	4,500	730

Average Removal of Bacteria and Organic Matter. — Filter No. 300.

Per Cent. of Bacteria removed by —			Per Cent. of B. Coli removed by —			Per Cent. of Albuminoid Ammonia removed.
Coagulation and Sedimentation.	Filter.	System.	Coagulation and Sedimentation.	Filter.	System.	
79.2	45.9	88.8	71.1	83.8	95.3	58.2

Filter No. 100.

Filter No. 100 is 1/20000 of an acre in area, and contained, during 1907, 42 inches of sand of an effective size of 0.26 millimeter. It was first put into operation on Jan. 1, 1898, and has always been flooded with the effluent from Septic Tank A. The surface of the filter was raked to a depth of 3 inches once a week throughout the year, and was dug over to a depth of 6 inches on January 26, February 13, February 26 and March 7. The filter was allowed to rest from Dec. 1, 1906, to Dec. 9, 1906, and from Jan. 16, 1907, to Jan. 27, 1907.

The sand has become badly clogged with organic matter, and it has been impossible to operate the filter at the high rates followed in previous years and obtain a satisfactory effluent.

Filter No. 242.

Filter No. 242 is constructed of 48 inches of sand of an effective size of 0.41 millimeter, and was first put into operation on Feb. 1, 1904. The effluent from Septic Tank F was applied to this filter at a rate of about 100,000 gallons per acre daily. The surface was raked to a depth of 3 inches weekly throughout the year, and the filter rested from July 1 to July 7 and from October 31 to November 3, inclusive.

Effluent of Filter No. 100.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906. December, .	146,000	57	60	0.5	0.81	2.2300	.1290	9.85	2.21	.0410	1.05	12,000
1907. January, . .	129,600	54	61	4.5	1.53	1.8800	.2000	13.50	2.24	.0006	2.69	5,500
February, . .	95,800	54	53	0.5	–	2.4000	.4680	10.20	0.04	.0000	5.80	13,500
March, . .	50,000	61	57	0.3	0.25	1.1350	.0410	10.55	6.60	.0028	0.24	5,000
April, . .	50,000	57	–	0.1	0.06	0.2235	.0230	12.02	5.17	.0012	0.25	300
May, . . .	56,700	61	60	0.0	0.04	0.3280	.0278	15.80	5.29	.0004	0.25	550
June, . . .	65,000	66	66	0.0	0.09	0.3450	.0320	17.00	4.58	.0005	0.33	140
July, . . .	61,400	74	–	0.1	0.09	0.2064	.0388	17.10	5.29	.0005	0.28	1,375
August, . .	63,700	70	65	0.1	0.07	0.2842	.0333	17.45	5.42	.0006	0.30	625
September, .	65,000	68	67	0.1	0.07	0.1500	.0400	14.40	4.54	.0010	0.42	150
October, . .	65,000	64	61	0.1	0.09	0.1902	.0389	12.85	3.99	.0015	0.43	1,725
November, .	65,000	52	56	0.1	0.17	0.3920	.0380	12.60	4.70	.0004	0.74	1,200
Average, .	76,100	62	61	0.4	0.30	0.8137	.0925	13.61	4.17	.0042	1.07	3,500

Effluent of Filter No. 242.

[Parts per 100,000.]

Date.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.) Sewage.	Appearance.		Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906. December, .	100,000	72	0.0	0.07	.3500	.0410	14.10	7.06	.0003	.30	35
1907. January, .	100,000	71	0.0	0.08	.2000	.0540	12.80	6.47	.0002	.29	125
February, .	100,000	68	0.0	0.09	.1400	.0300	10.70	5.38	.0002	.25	235
March, . .	100,000	71	0.0	0.06	.2390	.0270	10.80	6.22	.0006	.26	64
April, . .	91,400	70	0.0	0.05	.1250	.0320	13.90	6.30	.0007	.24	39
May, . .	100,000	67	0.0	0.06	.1100	.0240	12.20	6.13	.0006	.17	225
June, . .	91,200	69	0.0	0.05	.1210	.0300	18.05	5.21	.0007	.33	134
July, . .	66,100	74	0.0	0.06	.0928	.0380	17.20	6.72	.0007	.38	40
August, . .	91,800	73	sl't.	0.26	.1280	.0280	16.60	5.29	.0076	.29	11
September, .	95,000	69	0.0	0.03	.1080	.0260	13.10	5.77	.0014	.35	245
October, . .	91,800	70	0.0	0.08	.0350	.0350	14.10	5.42	.0003	.33	43
November, .	100,000	67	0.0	0.08	.1600	.0320	10.50	11.26	.0040	.29	57
Average, .	93,900	70	0.0	0.08	.1507	.0331	13.67	6.44	.0014	.29	100

A STUDY OF THE RATE OF OPERATION OF SAND FILTERS.

Filters Nos. 312, 313, 314, 315 and 316.

These five filters, each 1/20000 of an acre in area, and constructed of sand of an effective size of 0.25 millimeter, were put into operation Oct. 1, 1906, to study comparatively the purification of sewage on sand filters operated at different rates, the effect of mode of application of sewage and the effect of doubling the depth of filtering material.

Filters Nos. 312, 313, 314 and 315 each contained 5 feet of sand, and Filter No. 316 contained 10 feet. Sewage was applied to Filter No. 312 at a rate of 50,000 gallons, to Filters Nos. 313 and 316 at a rate of 100,000 gallons and to Filters Nos. 314 and 315 at a rate of 150,000 gallons per acre daily. From December 1 to July 21 the sewage applied to Filter No. 315 was divided into six doses, applied at intervals two hours apart; and from July 22 to November 30 it was applied in eight doses, at intervals of five hours. · The sewage for each of the other filters was applied in one dose.

Filters Nos. 312, 313 and 316 were operated without disturbance of the surface and without any period of rest throughout the year. Filter No. 314 was raked 1 inch deep on May 19, October 3 and October 21, and was allowed to rest from May 19 to May 26, inclusive. Filter No. 315 was raked 2 to 3 inches deep on February 2, February 26, July 10, October 21 and November 22, and rested from January 31 to February 4, from July 6 to 21 and from October 12 to October 20, inclusive.

Effluent of Filter No. 312.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.												
December, .	50,000	39	58	0.0	0.03	.0106	.0214	12.05	3.86	.0010	.29	50
1907.												
January, . .	50,000	38	57	0.0	0.03	.1128	.0188	15.05	4.69	.0044	.26	73
February, . .	50,000	39	57	0.0	0.03	.0910	.0280	12.60	5.62	.0100	.25	54
March, . .	50,000	40	56	0.0	0.04	.1452	.0263	12.40	5.63	.0030	.22	250
April, . .	50,000	45	56	0.0	0.07	.4583	.0383	14.80	6.00	.0125	.37	230
May, . . .	50,000	55	59	0.0	0.07	.1855	.0265	16.25	6.22	.0029	.28	150
June, . .	50,000	61	67	0.0	0.06	.1933	.0265	16.25	4.88	.0005	.20	240
July, . . .	46,300	70	72	0.0	0.05	.1288	.0227	17.00	5.12	.0018	.14	1,170
August, . .	48,100	70	67	0.0	0.05	.0515	.0200	17.75	5.04	.0006	.18	925
September, .	50,000	66	58	0.0	0.03	.0092	.0156	13.00	4.45	.0002	.24	130
October, . .	50,000	55	45	0.0	0.07	.0211	.0158	12.40	4.78	.0003	.25	375
November, .	50,000	49	55	0.0	0.04	.0624	.0188	10.90	6.22	.0004	.26	200
Average, .	49,500	52	59	0.0	0.05	.1225	.0232	14.20	5.21	.0031	.25	320

Effluent of Filter No. 313.

1906.												
December, .	100,000	39	–	0.0	0.07	.0740	.0283	12.45	4.22	.0010	.32	200
1907.												
January, . .	100,000	38	–	0.0	0.10	.3750	.0370	16.30	4.45	.0008	.37	140
February, . .	100,000	39	–	0.0	0.11	.4000	.0300	11.60	5.21	.0002	.38	120
March, . .	100,000	40	–	0.0	0.07	.6900	.0520	12.75	6.09	.0008	.34	645
April, . .	100,000	45	58	0.0	0.08	.7210	.0445	15.45	6.51	.0021	.47	1,165
May, . . .	100,000	55	58	0.0	0.07	.2145	.0355	16.60	6.39	.0010	.33	250
June, . . .	100,000	61	67	0.0	0.08	.1680	.0383	18.35	5.54	.0053	.31	260
July, . . .	92,600	70	72	0.0	0.06	.1243	.0276	17.25	5.25	.0013	.24	600
August, . .	96,300	70	67	0.0	0.06	.0710	.0255	17.70	4.79	.0004	.22	2,725
September, .	98,000	66	58	0.0	0.05	.0242	.0212	12.30	4.03	.0000	.25	100
October, . .	100,000	55	55	0.0	0.08	.5371	.0263	12.80	3.60	.0021	.34	700
November, .	100,000	49	–	0.0	0.04	.1125	.0290	11.00	6.13	.0006	.36	2,550
Average, .	98,900	52	62	0.0	0.07	.2926	.0329	14.55	5.18	.0013	.33	800

Effluent of Filter No. 314.

[Parts per 100,000.]

Date.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.).		Appearance.		Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.												
December, .	150,000	39	60	0.1	0.15	0.5200	.0490	13.05	3.82	.3800	0.49	1,250
1907.												
January, . .	150,000	38	56	0.1	0.21	0.9400	.0640	16.60	3.71	.4100	0.45	2,250
February, . .	150,000	39	60	0.2	0.21	0.8600	.0620	11.20	3.83	.1200	0.70	3,000
March, . .	150,000	40	56	0.0	0.25	0.8800	.0420	12.40	5.38	.0022	0.57	675
April, . .	150,000	45	56	0.5	0.37	2.7425	.0840	15.80	2.51	.0226	0.89	1,850
May, . . .	117,000	55	59	0.6	0.78	3.2700	.1370	16.25	8.74	.0289	1.11	10,400
June, . . .	150,000	61	67	0.1	0.12	0.1886	.0387	17.48	5.26	.0057	0.30	550
July, . . .	138,900	70	72	1.0	0.17	0.4830	.0590	16.88	5.25	.0012	0.36	3,700
August, . .	144,400	70	66	0.5	0.12	0.3160	.0496	17.80	4.86	.0016	0.40	3,550
September, .	150,000	66	58	0.1	0.10	0.1204	.0332	13.30	4.12	.0002	0.41	550
October, . .	139,000	55	54	0.5	0.13	0.4402	.0510	11.78	4.83	.0010	0.46	3,600
November, .	150,000	49	–	0.3	0.10	0.4200	.0980	10.40	5.29	.0032	0.60	3,500
Average, .	144,900	52	60	0.3	0.23	0.9317	.0640	14.41	4.80	.0814	0.56	2,900

Effluent of Filter No. 315.

1906.												
December, .	150,000	39	61	0.0	0.09	0.2280	.0320	13.15	4.73	.0650	0.39	125
1907.												
January, . .	136,000	38	58	0.1	0.14	1.0700	.0590	16.25	3.01	.0170	0.53	184
February, . .	94,000	39	58	0.1	0.11	0.1260	.0350	12.30	4.45	.0100	0.40	700
March, . .	150,000	40	55	0.1	0.08	0.2390	.0345	12.40	5.66	.0110	0.35	885
April, . .	150,000	45	56	0.0	0.13	1.0120	.0490	15.30	5.29	.0017	0.47	130
May, . . .	150,000	55	58	0.0	0.11	0.3575	.0425	16.55	5.97	.0001	0.40	75
June, . . .	150,000	61	67	0.0	0.08	0.3065	.0410	18.05	5.72	.0005	0.33	240
July, . . .	25,900	70	73	0.0	0.08	2.0370	.1744	17.70	5.08	.0066	1.11	11,100
August, . .	143,300	70	66	0.1	0.07	0.1712	.0350	17.20	4.96	.0006	0.29	2,150
September, .	148,000	66	58	0.1	0.07	0.0676	.0290	13.10	3.36	.0002	0.35	345
October, . .	111,000	55	55	0.7	0.67	2.1500	.1660	13.95	3.14	.0182	1.65	16,900
November, .	90,400	49	55	0.5	1.90	5.8000	.2740	10.50	0.09	.0100	3.23	28,000
Average, .	124,900	52	60	0.1	0.29	1.1304	.0810	14.70	4.29	.0117	0.79	5,100

Effluent of Filter No. 316.

[Parts per 100,000.]

DATE.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
1906.												
December, .	100,000	39	57	0.0	0.08	0.0131	.0144	12.40	4.62	.0025	.25	50
1907.												
January, . .	100,000	38	51	0.1	0.07	0.2693	.0218	14.30	4.54	.0022	.29	84
February, . .	100,000	39	53	0.0	0.05	0.4600	.0400	12.50	5.80	.0010	.30	43
March, . .	100,000	40	55	0.1	0.05	0.1110	.0222	12.65	6.01	.0039	.28	1,075
April, . .	100,000	45	55	0.0	0.07	0.2075	.0249	14.35	5.83	.0115	.23	85
May, . . .	100,000	55	59	0.0	0.07	0.0947	.0261	16.05	6.17	.0083	.25	75
June, . . .	100,000	61	67	0.0	0.07	0.0722	.0286	17.60	4.88	.0060	.27	52
July, . . .	92,600	70	71	0.1	0.04	0.0710	.0196	17.50	5.67	.0060	.27	310
August, . .	96,300	70	66	0.0	0.03	0.0324	.0185	17.20	4.99	.0031	.18	375
September, .	100,000	66	58	0.1	0.04	0.0062	.0152	13.40	3.95	.0010	.18	7
October, . .	100,000	55	54	0.0	0.03	0.0131	.0153	12.50	4.69	.0024	.16	50
November, .	100,000	49	–	0.0	0.02	0.2850	.0200	10.90	6.05	.0060	.23	105
Average, .	99,100	52	59	0.0	0.05	0.1363	.0222	14.28	5.27	.0045	.24	200

REMOVAL OF BACTERIA BY FILTERS OF VARIOUS TYPES.

The efficiency of various types of sewage filters in removing bacteria have been discussed from time to time in the reports of the Lawrence Experiment Station, and the results of B. coli tests and the removal of that type of bacteria were given in the report for 1904. During 1907, in addition to the usual counts of the numbers of bacteria, as shown by agar plates incubated at 20° C., determinations of the numbers of B. coli and of the total number of bacteria developing on litmus-lactose-agar plates at 40° C. in eighteen hours, were a part of the routine analytical procedure. The significance of total numbers of bacteria and of B. coli are well understood. The particular significance of the 40° C. counts is that the majority of types of bacteria growing rapidly at this temperature have their origin in the excreta of man and the higher animals; that is, the numbers of such bacteria represent, more truly than do the usual 20° C. counts, the amount of pollution in any given water.

Three methods of preliminary treatment of sewage for purification were used during the year, these being sedimentation, septic tanks, and straining through 6 inches of fine coal. Of these, straining was most effective in removing total bacteria. Septic action was less effective than straining, and sedimentation was the least effective of the three, the percentage removal of total bacteria by straining being 59.40 per cent., by septic action 43.80 per cent, and by sedimentation 27.20 per cent. The removal of 40° bacteria and of B. coli by these three systems was less than was the total bacterial removal, and the relative efficiencies of the different systems was changed, Septic Tank A removing 43 per cent. of the 40° bacteria and 38.90 per cent. of the B. coli, Strainer E removing 39 per cent. and 34.50 per cent., respectively, of these two types, and sedimentation removing 33.20 per cent. of the 40° bacteria and 31.40 per cent. of the B. coli. Septic Tank F, to which sewage sludge was applied, and which was operated with a considerable storage period, was more effective in eliminating bacteria than was Septic Tank A, which received regular sewage, the efficiency of Septic Tank F being 73.40 per cent. removal of total bacteria, 58.70 per cent. removal of 40° bacteria and 56.50 per cent. removal of B. coli.

All of the out-of-door intermittent sand filters showed a good bacterial efficiency, the average removal of total bacteria being 99.74 per cent., the least effective being Filter No. 6, with an efficiency of 99.22 per cent., and the most effective being Filters Nos. 2 and 4, with efficiencies of 99.98 per cent. The average removal of 40° bacteria and of B. coli by these filters was 99.50 per cent, and 99.47 per cent., respectively, Filters Nos. 2, 4 and 306 removing 99.99 per cent. of both types, and Filter No. 6, the least efficient of all, removed about 98 per cent. of both types. The efficiencies of intermittent sand Filters Nos. 312 to 316, inclusive, which were located inside the filter house, were practically the same as for the out-of-door filters; and this was true also of intermittent sand Filters Nos. 100 and 242, which were operated with septic sewage.

Of the four primary contact filters, Nos. 175, 176, 221 and 251, Filter No. 176 was most efficient, removing 17.30 per cent. of the total bacteria, 14.80 per cent. of the 40° bacteria and 62 per cent. of the B. coli. Filter No. 175, operated with strained sewage, removed only 14.80 per cent. of the total bacteria, and Filter No. 251 removed only 26.50 per cent. of the 40° bacteria and 33 per cent. of the B. coli. Filter No. 237, operated as a secondary contact filter with the effluent from Filter No. 221, removed 49.70 per cent. of the total bacteria, 49 per cent. of the 40° bacteria and 56.40 per cent. of the B. coli.

The average efficiency of the six sprinkling filters was 84.27 per cent. removal of total bacteria, 87.42 per cent. removal of 40° bacteria and 86.59 per cent. removal of B. coli. Filter No. 135 was most efficient, with an average removal of 95.58 per cent. of the total bacteria, 96.26 per cent. of the 40° bacteria and 96.13 per cent. of the B. coli; while Filter No. 233 was least efficient, removing 67.80 per cent. of the total bacteria, 77.10 per cent. of the 40° bacteria and 76.30 per cent. of the B. coli. Considered purely from a bacteriological standpoint, the sprinkling filters were far more effective than were the contact filters.

Of the three secondary sand filters operated with sprinkling filter effluents, Filter No. 224 removed 99.16 per cent. of the total bacteria, 97.96 per cent. of the 40° bacteria and 97.97 per cent. of the B. coli; while Filter No. 249, the least effective of the three, removed 95.92 per cent. of the total bacteria and over 83 per cent. of the 40° bacteria and of B. coli.

Considering the various combinations of preliminary treatments and filters as systems or units, excluding the intermittent sand filters operated with untreated sewage, the system represented by Filter No. 224, which received sewage which had been settled, filtered through sprinkling Filters Nos. 135 and 136 and again settled, was most efficient, the removal of total bacteria being 99.86 per cent., of 40° bacteria 99.96 per cent. and of B. coli 99.97 per cent. Septic treatment followed by intermittent sand filtration in Filter No. 100 removed 99.62 per cent. of the total bacteria, 99.36 per cent. of the 40° bacteria and 99.38 per cent. of the B. coli. Sedimentation followed by contact filtration, as represented by Filter No. 176, removed 79.85 per cent. of the total bacteria, 76.50 per cent. of the 40° bacteria and 73.90 per cent. of the B. coli, this process being more effective than straining combined with contact filtration, as represented by Filter No. 176. Sedimentation followed by double contact filtration, as represented by the 221–237 combination, removed 77.25 per cent. of the total bacteria, 80.70 per cent. of the 40° bacteria and 84.40 per cent. of the B. coli, being less effective in removing total bacteria, but more effective in removing 40° bacteria and B. coli, than the system represented by Filter No. 176. The average percentage removal of bacteria by the various preparatory treatments, primary and secondary filters and the bacterial numbers from which they were computed are shown in the following table: —

Table showing Removal of 20° and 40° Bacteria and of B. Coli by Sewage Filters.

	Bacteria per Cubic Centimeter.		B. Coli per Cubic Centimeter.	Per Cent. removed.		
				Bacteria.		B. Coli.
	20° C.	40° C.		20° C.	40° C.	
Lawrence street sewage,	1,184,100	372,000	296,900	–	–	–
Regular sewage,	913,100	280,300	226,000	–	–	–
Sewage for Filters Nos. 1 to 10,	789,600	228,300	175,200	–	–	–
Sewage for Filter No. 306,	555,600	173,900	136,300	–	–	–
Strainer E,	371,000	171,000	148,000	59.40	39.00	34.50
Settled sewage,	665,200	187,200	154,500	27.20	33.20	31.40
Sewage for Septic Tank A,	1,192,900	297,500	228,500	–	–	–
Septic Sewage A,	669,300	170,400	140,400	43.80	43.00	38.90
Sewage for Septic Tank F,	1,750,600	341,100	299,400	–	–	–
Septic Sewage F,	466,700	140,800	130,300	73.40	58.70	56.50
Filter No. 1,	3,800	2,300	1,900	99.51	98.99	98.92
Filter No. 2,	190	11	8	99.98	99.99	99.99
Filter No. 4,	150	26	11	99.98	99.99	99.99
Filter No. 5C,	3,300	2,600	2,300	99.64	99.07	98.98
Filter No. 6,	6,200	4,700	3,600	99.22	97.94	97.94
Filter No. 9A,	1,100	450	310	99.86	99.80	99.82
Filter No. 10,	1,900	510	350	99.76	99.78	99.80
Filter No. 100,	3,500	1,800	1,400	99.48	98.94	99.00
Filter No. 242,	105	18	14	99.98	99.99	99.99
Filter No. 305,	1,700	200	160	99.81	99.93	99.93
Filter No. 306,	750	18	12	99.87	99.99	99.99
Filter No. 312,	320	2	2	99.96	99.99	99.99
Filter No. 313,	790	8	6	99.91	99.99	99.99
Filter No. 314,	2,900	1,600	1,600	99.68	99.43	99.34
Filter No. 315,	5,100	1,200	1,030	99.44	99.57	99.54
Filter No. 316,	200	1	0	99.98	99.99	100.00
Applied 224, 249, 250,	153,900	5,400	3,600	–	–	–
Filter No. 224,	1,300	110	73	99.16	97.96	97.97
Filter No. 249,	6,300	880	600	95.92	83.70	83.30
Filter No. 250,	6,000	710	400	96.10	86.90	88.90
Filter No. 175,	316,300	84,600	69,100	14.80	50.50	53.40
Filter No. 176,	191,400	65,900	59,000	71.30	64.80	62.00
Filter No. 221,	414,200	105,600	80,600	37.80	43.30	48.00
Filter No. 237,	208,300	54,000	35,200	49.70	49.00	56.40
Filter No. 251,	482,100	124,500	93,600	28.00	26.50	33.00
Filter No. 135,	29,400	7,000	6,000	95.58	96.26	96.13
Filter No. 136,	55,400	8,000	6,500	91.67	95.73	95.81
Filter No. 233,	214,300	42,800	36,800	67.80	77.10	76.30
Filter No. 235,	126,100	31,600	29,100	81.00	83.10	81.20
Filter No. 247,	148,200	40,200	36,700	77.80	78.50	76.40
Filter No. 248,	54,700	11,600	9,800	91.77	93.80	93.68

WATER FILTRATION.

Special attention was paid during 1907 to the operation of various combinations of filters for the purpose of studying double filtration, to the filtration of water of varying degrees of pollution, and to the use of coagulants in connection with the filtration of polluted river water. In studying double filtration some of the preliminary filters were operated at rates much higher than has been the usual practice, and investigations were made of the relative economy of removing surface clogging by scraping and by washing. The effects of the period of service and the accumulation of organic matter within the filtering material upon the maximum quantity of water which may be passed through a filter also received some attention.

In addition to the usual determinations of numbers of bacteria and tests for B. coli in the raw and filtered waters, determinations were made of the total number of bacteria developing in eighteen hours at 40° C., and the number of these bacteria which produce acid fermentation of lactose. Tests of this character are believed to be of much value in the daily operation of water filters, as affording a quick determination of the results of filtration, and also serve as a check upon the other bacterial determinations. To avoid the confusion which must ensue until the interpretation and significance of any new series of determinations are thoroughly understood, the usual bacterial tables are given, as in previous years, and the results of the 40° C. counts are included in a separate table at the end of this report.

It will be noted that the effective size of sand given for a number of the filters varies slightly from that stated in previous reports. During the earlier part of the year analyses were made of the sand in each of the water filters in operation, and the average effective size of the sand at that time is herein stated whenever that size is different from that originally determined when the sand was placed in the filter.

A summary of the operation of the various filters and of their removal of bacteria and albuminoid ammonia is given in the following table: —

Summary of Operation of Water Filters during 1907.

Filters operated with Canal Water, scraped when necessary.

Filter No.	Period.	Total Days operated.	Number of Times scraped or washed.	Average Quantity of Water Filtered (Million Gallons per Acre). Per Day.	Average Quantity of Water Filtered (Million Gallons per Acre). Per Scraping or Washing.	Average Length of Run (Days).	Per Cent. removed. Bacteria.	Per Cent. removed. Albuminoid Ammonia.
8,	Dec. 1-Nov. 30,	306	12	2.6	66.6	25.5	98.8	44.0
220,	Dec. 1-Jan. 31,	52	5	4.4	46.6	10.4	94.7	34.0
220,	Feb. 1-Apr. 30,	80	2	2.9	115.5	40.0	97.7	34.8
220,	May 1-Nov. 30,	201	8	4.5	111.0	25.1	99.0	40.0
280,	Dec. 1-Dec. 31,	25	5	12.9	64.0	5.0	90.2	27.2
286,	May 1-June 30,	58	1	2.9	170.0	58.0	47.0	45.2
317,	July 14-Nov. 30,	133	1	3.0	396.0	133.0	93.3	50.5

Filters operated with Canal Water + Sewage, scraped when necessary.

Filter No.	Period.	Total Days operated.	Number of Times scraped or washed.	Per Day.	Per Scraping or Washing.	Average Length of Run (Days).	Bacteria.	Albuminoid Ammonia.
219,	Dec. 1-Apr. 30,	77	11	4.2	27.0	7.0	80.8	54.3
317,	Dec. 1-Apr. 14,	105	21	6.0	30.0	5.0	84.9	66.4
317,	Apr. 15-July 13,	85	3	2.8	80.0	28.3	91.0	60.8

Filters operated with Canal Water, washed when necessary.

Filter No.	Period.	Total Days operated.	Number of Times scraped or washed.	Per Day.	Per Scraping or Washing.	Average Length of Run (Days).	Bacteria.	Albuminoid Ammonia.
280,	Jan. 1-June 30,	173	45[1]	13.2	50.0	3.8	83.3	19.5
280,	July 1-Nov. 30,	150	56[1]	22.2	59.2	2.7	87.9	22.2
330,[2]	July 1-Nov. 30,	128	12[1]	4.6	45.0	10.7	92.7	50.9
331,	July 1-Nov. 30,	147	31[3]	95.6	432.0	4.7	78.2	24.0

Filters operated with Filtered Water, scraped when necessary.

Filter No.	Period.	Total Days operated.	Number of Times scraped or washed.	Per Day.	Per Scraping or Washing.	Average Length of Run (Days).	Bacteria.	Albuminoid Ammonia.
218,	Dec. 1-Apr. 30,	80	4	4.8	100.0	20.0	18.8	9.2
244,	Dec. 1-Jan. 31,	49	4	18.7	204.0	12.2	41.4	0.7
244,	Feb. 1-Apr. 30,	80	1	11.5	924.0	80.0	40.9	16.6
244,	May 1-Nov. 30,	184	5	18.5	684.0	36.8	39.5	8.0
281,	Dec. 1-Nov. 30,	321	8	7.0	280.0	40.1	90.0	25.0
286,	Dec. 1-Apr. 30,	64	3	7.7	164.0	21.3	40.3	28.3
286,	July 1-Nov. 30,	145	1	4.0	574.0	145.0	76.4	21.0

[1] Surface of filter washed.

[2] Applied water treated with very small amount of sulphate of alumina.

[3] Whole filter washed.

LAWRENCE CITY FILTER.

The Lawrence city filter was constructed in 1893, and dividing walls separating it into three sections were built during 1902. The average depth of sand in the filter is about 4 feet, and the net filtering area, after deducting division walls, gate-chambers and lateral carriers, is about 2.2 acres. As originally constructed the filter contained sand of two different grades, the portions of the filter immediately over the collecting underdrains being of finer sand than that in the remainder of the filter. Through the operations of scraping, washing and replacing sand the two grades of sand have become quite thoroughly mixed in the upper layers of the filter, and at the present time this upper sand has an effective size of approximately 0.25 millimeter.

On November 5 an additional covered filter, ¾ of an acre in area, and containing 4½ feet of sand of an average effective size of 0.25 millimeter, was put into operation. The effluent from this filter was wasted until the filter had attained a proper bacterial efficiency, and was not pumped into the distribution system until after November 30.

The following tables present the average chemical and bacterial analyses of many samples of the Merrimack River water collected during the year as it flows upon the filter, and of the filtered water collected at different points upon the supply system. During a considerable portion of the year bacterial samples were collected daily, and samples for chemical analyses twice each month.

Merrimack River. — Intake of the Lawrence City Filter.

[Parts per 100,000.]

Date.	Temperature (Deg. F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Iron.	Hardness.
					Albuminoid.							
		Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
1906.												
December,	–	0.1	.37	.0275	.0261	.0204	.59	.017	.0004	.74	.0720	1.3
1907.												
January,	–	0.0	.44	.0113	.0194	.0174	.33	.021	.0002	.65	.0365	1.0
February,	–	0.1	.37	.0184	.0237	.0203	.46	.021	.0003	.67	.0550	1.3
March,	–	0.1	.35	.0156	.0226	.0179	.51	.016	.0003	.61	.0505	1.1
April,	47	1.1	.39	.0043	.0190	.0153	.15	.012	.0001	.58	.0930	0.6
May,	55	0.0	.37	.0096	.0204	.0189	.32	.008	.0002	.50	.0500	0.8
June,	67	0.2	.41	.0204	.0355	.0220	.31	.010	.0004	.68	.0680	1.1
July,	78	0.2	.44	.0215	.0266	.0205	.38	.013	.0005	.62	.0700	1.2
August,	74	0.2	.50	.0215	.0336	.0227	.51	.016	.0007	.58	.0695	1.6
September,	69	0.2	.39	.0324	.0266	.0221	.55	.014	.0006	.59	.0725	1.4
October,	51	0.1	.55	.0105	.0247	.0220	.32	.014	.0003	.84	.0610	0.9
November,	44	0.4	.64	.0036	.0166	.0152	.20	.004	.0002	.69	.0500	0.3
Average,	61	0.2	.44	.0164	.0246	.0196	.39	.014	.0004	.65	.0623	1.2

Average Chemical Analyses.

Merrimack River. — Intake of the Lawrence City Filter.

Average,	61	0.2	.44	.0164	.0246	.0196	.39	.014	.0004	.65	.0623	1.2

Effluent of the Lawrence City Filter.

Average,	53	0.1	.39	.0115	.0102	–	.39	.030	.0001	.45	.1183	1.4

Water from the Outlet of the Distributing Reservoir.

Average,	61	0.1	.37	.0067	.0103	–	.39	.033	.0001	.39	.0873	1.3

Average Chemical Analyses — Concluded.

Water from a Tap at Lawrence City Hall.

[Parts per 100,000.]

	Temperature (Deg. F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Iron.	Hardness.
		Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.			
Average, . . .	53	0.1	.36	.0049	.0103	–	.38	.033	.0001	.38	–	1.3

Water from a Tap at the Lawrence Experiment Station.

Average, . . .	55	0.1	.34	.0034	.0094	–	.37	.033	.0000	.36	–	1.3

Merrimack River as it flows upon Lawrence City Filter.

[Average of Bacterial Analyses.]

Date.	Average Number of Bacteria per Cubic Centimeter.	Average Number of B. Coli per Cubic Centimeter.	Date.	Average Number of Bacteria per Cubic Centimeter.	Average Number of B. Coli per Cubic Centimeter.
1906.			**1907.**		
December, . . .	2,900	153	July, ...	2,600	62
1907.			August, . . .	3,000	168
January, . . .	3,900	101	September, . . .	5,700	87
February, . . .	3,000	54	October, . . .	1,400	105
March, . . .	3,200	58	November, . . .	3,300	140
April, . . .	2,200	25	Average, . .	2,700	90
May, . . .	700	42			
June, . . .	950	69			

Effluent of Lawrence City Filter.

[Average of Bacterial Analyses.]

	Average Number of Bacteria per Cubic Centimeter.	Per Cent. removed. (Efficiency).	Per Cent. of Samples containing B. Coli.	
			1 Cubic Centimeter.	100 Cubic Centimeters.
Average, ...	19	99.2	5.2	59.8

Water from the Outlet of the Lawrence Reservoir.

Average, ...	25	–	0.0	43.0

Water from a Tap at Lawrence City Hall.

Average, ...	28	–	0.0	47.5

Lawrence City Water from a Tap at the Experiment Station.

[Average of Bacterial Analyses.]

	Average Number of Bacteria per Cubic Centimeter.	Per Cent. removed (Efficiency).	PER CENT. OF SAMPLES CONTAINING B. COLI.	
			1 Cubic Centimeter.	100 Cubic Centimeters.
Average, ...	20	–	3.0	48.4

Filter No. 8A.

This filter, 1/200 of an acre in area, first put into operation in 1893, contains about 42 inches of sand of an average effective size of 0.28 millimeter, and was operated at a rate of 3,000,000 gallons per acre daily throughout the year. Owing to conditions not yet completely determined, it was very difficult to maintain even this low rate during the winter months, although the filter was covered and no appreciable amount of ice formed on the surface. The filter was scraped twelve times, and, by reason of low water in the Essex Company's canal, high water in the river, etc., was out of operation fifty-five days during the year.

Canal Water (Merrimack River Water).

[Parts per 100,000.]

DATE.	Temperature (Deg. F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	ALBUMINOID.			Nitrates.	Nitrites.			
					Total.	In Solution.						
1906.												
December, . .	42	0.1	.37	.0168	.0206	.0182	.54	.022	.0002	0.69	79.5	1.3
1907.												
January, . .	36	0.1	.41	.0139	.0182	.0169	.39	.021	.0002	0.64	33.6	1.0
February, . .	34	0.1	.35	.0182	.0176	.0160	.44	.022	.0002	0.61	–	1.2
March, . . .	39	0.1	.38	.0175	.0190	.0167	.32	.016	.0004	0.63	73.0	0.9
April, . . .	43	0.0	.36	.0063	.0187	.0143	.27	.015	.0001	0.49	100.0	0.7
May, . . .	59	0.1	.39	.0050	.0182	.0140	.32	.018	.0002	0.49	92.2	0.9
June, . . .	64	0.1	.41	.0119	.0192	.0169	.33	.016	.0004	0.58	33.8	1.0
July, . . .	74	0.1	.42	.0206	.0216	.0164	.39	.022	.0015	0.47	34.2	1.2
August, . . .	73	0.1	.44	.0189	.0232	.0170	.50	.015	.0015	0.45	27.9	1.4
September, . .	69	0.3	.43	.0128	.0198	.0172	.49	.019	.0006	1.11	23.2	1.2
October, . .	52	0.2	.53	.0094	.0211	.0172	.32	.016	.0003	0.82	107.5	0.7
November, . .	47	0.5	.58	.0044	.0204	.0178	.10	.008	.0002	0.74	94.0	0.4
Average, . .	53	0.1	.42	.0130	.0198	.0166	.37	.018	.0005	0.56	63.5	1.0

Effluent of Filter No. 8A.

[Parts per 100,000.]

DATE.	Quantity Applied. Gallons per Acre Daily.	Temperature (Deg. F.).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
			Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
1906.												
December, .	3,736,000	35	0.0	.30	.0136	.0124	.53	.027	.0000	.54	54.7	1.3
1907.												
January, . .	2,857,000	35	0.0	.31	.0069	.0114	.35	.028	.0000	.46	30.2	1.1
February, .	1,978,000	34	0.1	.23	.0058	.0112	.45	.038	.0000	.45	15.9	1.2
March, . .	1,608,000	34	0.0	.22	.0050	.0132	.43	.039	.0002	.53	53.0	1.0
April, . .	2,739,000	46	0.1	.32	.0016	.0102	.22	.018	.0002	.53	45.7	0.6
May, . .	2,669,000	55	0.0	.24	.0012	.0106	.30	.028	.0000	.33	56.2	0.8
June, . .	2,993,000	63	0.1	.31	.0026	.0104	.35	.030	.0008	.43	28.9	0.9
July, . .	2,851,000	74	0.0	.26	.0044	.0127	.39	.020	.0034	.43	39.3	1.2
August, . .	2,813,000	73	0.0	.24	.0026	.0080	.48	.027	.0002	.32	5.8	1.4
September, .	2,882,000	69	0.0	.24	.0030	.0094	.52	.014	.0000	.95	2.0	1.3
October, . .	2,251,000	53	0.0	.37	.0032	.0122	.33	.030	.0001	.58	89.5	1.0
November, .	2,176,000	–	–	–	–	–	–	–	–	–	–	–
Average, .	2,629,400	52	0.0	.28	.0045	.0111	.40	.027	.0004	.50	38.3	1.1

Merrimack River Water (Essex Company's Canal).

[Average of Bacterial Analyses.]

DATE.	Average Number of Bacteria per Cubic Centimeter.	Average Number of B. Coli per Cubic Centimeter.	DATE.	Average Number of Bacteria per Cubic Centimeter.	Average Number of B. Coli per Cubic Centimeter.
1906.			**1907.**		
December, . . .	2,200	152	July, ...	6,200	194
1907.					
January, . . .	2,300	80	August, . . .	4,100	141
February, . . .	1,700	50	September, . .	7,100	122
March, . . .	1,300	30	October, . . .	1,300	80
April, ...	1,300	26	November, . . .	2,600	95
May, ...	700	33	Average, . .	2,700	87
June, ...	1,700	42			

Effluent of Filter No. 8A.

[Average of Bacterial Analyses.]

Date.	Average Number of Bacteria per Cubic Centimeter.	Per Cent. removed (Efficiency).	Per Cent. of Samples containing B. Coli, 1 Cubic Centimeter.
1906.			
December,	75	96.6	91.0
1907.			
January,	45	98.0	92.4
February,	44	97.4	100.0
March,	20	98.5	33.3
April,	21	98.4	0.0
May,	24	96.6	7.7
June,	90	94.7	8.3
July,	21	99.7	12.5
August,	21	99.5	18.2
September,	11	99.8	0.0
October,	8	99.4	0.0
November,	20	99.2	12.5
Average,	33	98.2	31.3

FILTRATION OF WATER OF VARYING DEGREES OF POLLUTION.

Filters Nos. 218, 219 and 220.

The experiment with these three filters, started in July, 1903, for the purpose of studying comparatively the chemical and bacterial quality of effluents resulting from the filtration of waters of different degrees of pollution, was continued during the first five months of the year.

Filters Nos. 218 and 219 were $\frac{1}{20000}$ of an acre in area, and Filter No. 220 was $\frac{1}{5000}$ of an acre in area. At the end of the experiment, Filters Nos. 219 and 220 contained 28 inches and 35 inches, respectively, of sand of an effective size of 0.20 millimeter, and Filter No. 218 contained 37 inches of sand of an effective size of 0.23 millimeter, the somewhat higher effective size of sand in the latter filter being due to washing the filter in 1906 to remove accumulated iron. Filters Nos. 218 and 219 were operated at a rate of 5,000,000 gallons per acre daily during the entire five months, and Filter No. 220 was operated during December and January at a 5,000,000 rate, from February 1 to April 30 at a 3,000,000 rate, and after the completion of the experiments mentioned above was continued in operation at a rate of 5,000,000 gallons per acre daily as a part of the studies in double filtration. Filter No. 218 received the Lawrence filtered water taken from the distribution main at the experiment station. The filter was scraped four times during the five months of operation, and was out of operation from December 28 to January 17 and from February 24 to March 21, inclusive, on account of a shortage in the city water supply.

Filter No. 219 has always been operated with Merrimack River water with which a small proportion of strained sewage has been mixed. The filter was scraped eleven times during the five months of operation, and was out of operation seventy-four days, owing to low water in the Essex Company's canal. Filter No. 220 has always received Merrimack River water. This filter was scraped fifteen times during the year, and was out of operation, by reason of low water in the Essex Company's canal, thirty-one days during the year. Tables showing the average chemical and bacterial analyses of the effluents from these filters follow:—

Average Chemical Analyses.

Effluent of Filter No. 218.[1]

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Deg. F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as—		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.			Nitrates.	Nitrites.			
					Total.	In Solution.						
4,767,000,	46	0.0	.18	.0018	.0101	-	0.37	.028	.0000	.32	69.7	1.1
Applied Water — Filter No. 219.												
-	47	1.1	.51	.3031	.0657	.0567	1.28	.029	.0009	.82	55.7	2.0
Effluent of Filter No. 219.[1]												
4,204,300,	48	0.1	.41	.1729	.0300	-	1.08	.037	.0074	.60	29.6	1.6
Effluent of Filter No. 220.[2]												
4,195,800,	54	0.0	.31	.0037	.0123	-	0.35	.022	.0001	.49	36.2	1.0

[1] December, 1906, to April, 1907, inclusive. [2] December, 1906, to November, 1907, inclusive.

Average Bacterial Analyses.

Filter No. 218.[1]

Applied Water.		Effluent.		Per Cent. of Bacteria removed (Efficiency).
Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	Per Cent. of Samples containing B. Coli.	
16	-	13	18.8	24.0
Filter No. 219.[1]				
49,000	4,000	10,600	80.8	100.0
Filter No. 220.[2]				
2,700	87	48	98.2	43.5

[1] Five months. [2] Twelve months.

REVIEW OF EXPERIMENTS ON FILTRATION OF WATER OF VARYING DEGREES OF POLLUTION.

The experiment with Filters Nos. 218, 219 and 220, extending over nearly four years, may be divided into two periods, according to the rate at which the filters were operated. During the first two and one-half years Filters Nos. 218 and 220 were operated at a rate of 2,500,000 gallons per acre daily, and during the last sixteen months they were operated at a rate of 5,000,000 gallons per acre daily. Filter No. 219 was operated at a like rate during the first period, but during the last five months of 1905 it was operated at a 2,500,000 rate, instead of at a 5,000,000 rate. Considering the periods of operation at the different rates as contemporary, the water applied to Filter No. 218 during the first or 2,500,000-rate period contained 630 bacteria per cubic centimeter, that applied to Filter No. 220 contained 9,100 bacteria and that applied to Filter No. 219 contained 38,000 bacteria, and the average number of bacteria in the effluents from the three filters was 16, 53 and 108, respectively; showing a removal of bacteria of 97.5 per cent. for Filter No. 218, of 99.4 for Filter No. 220 and of 99.7 per cent. for Filter No. 219. The average amount of albuminoid ammonia in the applied water for these three filters during the same period was .0095, .0203 and .0269 parts per 100,000, respectively, and the amount of albuminoid ammonia in the filtered waters was .0069, .0115 and .0115 parts per 100,000, respectively; a removal of 27.4 per cent. by Filter No. 218, of 43.4 by Filter No. 220 and of 57.3 by Filter No. 219. During the period when the filters were operated at a rate of 5,000,000 gallons per acre daily the average number of bacteria in the water applied to Filter No. 218 contained 24 bacteria per cubic centimeter, that applied to Filter No. 220 contained 3,400 bacteria per cubic centimeter and that applied to Filter No. 219 contained 30,000 bacteria per cubic centimeter. During the same period the numbers of bacteria in the effluents from these three filters were 11, 57 and 4,800, respectively; showing a bacterial removal of 54.2 per cent. by Filter No. 218, of 98.3 per cent. by Filter No. 220 and of 84.0 per cent. by Filter No. 219. The average amount of albuminoid ammonia in the applied water for these three filters during this period was .0090, .0186 and .0385 parts per 100,000, respectively, and the amount of albuminoid ammonia in the effluents was .0082, .0114 and .0180 parts per 100,000, respectively; a removal of 9.0 per cent. by Filter No. 218, of 38.7 per cent. by Filter No. 220 and of 53.3 per cent. by Filter No. 219. The efficiency of none of the filters in removing bacteria or albuminoid ammonia was as good when operating at the 5,000,000 rate as when operating at the 2,500,000 rate; although in the case of Filters Nos. 218 and 220 this efficiency was influenced to some extent by difference in the character of the water applied during the two periods.

During the entire period of operation, Filter No. 218, which received the least polluted water, was scraped thirty-one times, a total of 17 inches of sand being removed; Filter No. 220 was scraped forty-seven times, a total of 19 inches of sand being removed; and Filter No. 219, which received the most polluted water, was scraped sixty-seven times, a total of 26 inches of sand being removed. A certain proportion of the scraping on Filter No. 218 was caused by suspended iron in the applied water, and this should be considered in comparing the scraping results of the three filters. The average depth of scraping, computed from the above figures, was 0.55 inch for Filter No. 218, 0.40 inch for Filter No. 220 and 0.39 inch for Filter No. 219; and the average amount of sand removed per million gallons filtered was 0.55 cubic yard for Filter No. 218, 0.73 cubic yard for Filter No. 220 and 0.97 cubic yard for Filter No. 219. A summary of the operation of, and the results obtained with, these three filters is contained in the following table: —

Filter No. 218.

PERIOD OF OPERATION.	Rate. — Million Gallons per Acre Daily.	BACTERIA PER CUBIC CENTIMETER.		ALBUMINOID AMMONIA (PARTS PER 100,000).		PER CENT. REMOVED.		Number of Times scraped.	Million Gallons per Acre filtered between Scrapings.	Cubic Yards of Sand removed per Million Gallons filtered.
		Applied Water.	Effluent.	Applied Water.	Effluent.	Bacteria.	Albuminoid Ammonia.			
July 1, 1903, to Dec. 31, 1905,	2.44	630	16	.0095	.0069	97.5	27.4	14	153	0.48
Jan. 1, 1906, to April 30, 1907,	4.86	24	11	.0090	.0082	54.2	9.0	17	117	0.63

Filter No. 220.

July 1, 1903, to Dec. 31, 1905,	2.36	9,100	53	.0203	.0115	99.4	43.4	20	83	0.65
Jan. 1, 1906, to April 30, 1907,	4.07	3,400	57	.0186	.0114	98.3	38.7	27	69	0.78

Filter No. 219.

July 1, 1903, to April 30, 1905, and Aug. 1, 1905, to Dec. 31, 1905.	2.35	38,000	108	.0269	.0115	99.7	57.3	24	69	0.75
May 1, 1905, to July 31, 1905, and Jan. 1, 1906, to April 30, 1907.	4.54	30,000	4,800	.0385	.0180	84.0	53.3	43	46	1.13

DOUBLE FILTRATION.

Five different systems of double filtration, including the Lawrence city filter and seven experimental filters, were studied during the year. Filter No. 218, operated with Lawrence city water, filtered by the city filter, and Filter No. 220, whose effluent was applied to Filter No. 244, have already been described. Filters Nos. 280 and 331 were operated as preliminary or roughing filters, or, as this type of filter is usually designated, pre-filters, and Filters Nos. 244 and 281 and 286 as secondary filters with water which had already undergone filtration.

Pre-filters Nos. 280 and 331.

Filter No. 280, $\frac{1}{20000}$ of an acre in area, was first put into operation on Nov. 30, 1905, and during the greater part of the year contained 6 inches of sand of an average effective size of 0.30 millimeter. The filter was operated with canal water at a rate of 15,000,000 gallons per acre daily from December 1 to June 30, and at a rate of 25,000,000 gallons per acre daily from July 1 to November 30. Operating at this high rate the surface of the filter became clogged very quickly, and it was necessary to scrape the filter at frequent intervals, the frequent scrapings reducing the sand so that on January 1 only 6 inches remained. Beginning January 1 and continuing throughout the year, when the surface became clogged, it was washed, the surface sand being stirred up with a rake and the clogging matter removed by a shallow current of unfiltered water flowing across the top of the filter. This process of cleaning is accomplished much more quickly than is that of scraping, and there is no necessity for backfilling the filter to remove air, since the surface never becomes uncovered and air is never drawn into the interstices of the sand. The filter was scraped five times during December and washed one hundred and one times during the remaining eleven months; and it was out of operation during the whole or part of twenty-four hours on seventeen days during the year. The effluent of this filter was applied throughout the year to Filter No. 281.

Filter No. 331, $\frac{1}{80000}$ of an acre in area, containing 18 inches of sand of an effective size of 0.45 millimeter, was started July 7, 1907. It was operated as mechanical filters are usually operated, but without the use of chemicals, canal water being passed through a settling tank with a storage capacity of about five hours, and then applied to the filter at a rate of 100,000,000 gallons per acre daily, the entire body of sand being washed in the filter whenever it became so clogged that it would not pass water at the prescribed rate. It was necessary to wash thirty-one times during the five months that the filter was in operation, and, owing to low water in the Essex Company's canal, it was out of use on six different days.

Notwithstanding the high rates at which these two filters were operated and the small depth of filtering material, the average removal of bacteria by Filter No. 280 was over 85 per cent. and by Filter No. 331 about 80 per cent. The object of pre-filtration at high rates is to concentrate the clogging material upon units of relatively small area from which it may be economically removed without disturbing the main body of filters, and to equalize the quality of the water applied to secondary filters, in order that they may be operated more efficiently.

Secondary Filters Nos. 244, 281 and 286.

Filter No. 244, $\frac{1}{20000}$ of an acre in area, was first put into operation Feb. 16, 1904, and during 1907 contained about 37 inches of sand of an effective size of 0.24 millimeter. The effluent from Filter No. 220 was applied to this filter throughout the year, the rate of operation being 20,000,000 gallons per acre daily during December and January, 12,000,000 gallons per acre daily from February 1 to April 30, and 20,000,000 gallons per acre daily during the remainder of the year. The filter was scraped ten times and was out of operation fifty-two days during the year.

Filter No. 281, $\frac{1}{10000}$ of an acre in area, was first put into operation on Nov. 30, 1905, and during 1907 contained 44 inches of sand of an effective size of 0.23 millimeter. This filter was operated with the effluent from Filter No. 280 at a rate of 7,500,000 gallons per acre daily throughout the year. The filter was scraped eight times and was out of use forty-four days.

Filter No. 286, $\frac{1}{20000}$ of an acre in area, was first put into operation on Jan. 20, 1906. During 1907 the filter contained about 41 inches of sand of an effective size of 0.20 millimeter. This filter was operated with the effluent from Filter No. 219 from December 1 to April 30 at a rate of 10,000,000 gallons per acre daily. After Filter No. 219 went out of operation, canal water was applied to Filter No. 286 at a rate of 3,000,000 gallons per acre daily until June 30, after which time the effluent from mechanical filter No. 216 was applied during the remainder of the year at a rate of 6,000,000 gallons per acre daily. The filter was scraped five times and was out of operation one hundred and twenty-nine days during the year.

Considering the various double-filtration systems as units, the combined rate of the Lawrence city filter and Filter No. 218 was about 1,000,000 gallons per acre daily, and the water passed through a total depth of sand of about 7.5 feet; the combined rate of Filters Nos. 220

and 244 was 4,000,000 gallons per acre daily from December 1 to January 30 and from May 1 to November 30, and 2,400,000 gallons per acre daily from February 1 to April 30, and the water passed through a total depth of sand of about 6 feet; the combined rate of Filters Nos. 219 and 286 was 3,300,000 gallons per acre daily, and the water passed through a total depth of sand of 5.8 feet; the combined rate of Filters Nos. 216 and 286 was about 5,600,000 gallons per acre daily, and the water passed through about 5.3 feet of sand; and the combined rate of Filters Nos. 280 and 281 was about 5,000,000 gallons per acre daily from December 1 to June 30 and about 5,800,000 gallons from July 1 to November 30, the total depth of sand being about 4 feet. Comparing the 280–281 combination with Filter No. 8, which contained approximately the same depth of sand, we find that the removal of bacteria by the double-filtration system was slightly better at all times than was the case with the single filter; while the quantity of water filtered by the combination was about twice as great as that filtered by the single filter. A similar comparison between the 280–281 combination and Filter No. 220, which was operated at a rate nearly as great as the combined rate of the double-filtration system, shows that the removal of bacteria was also more satisfactory with two filters than with one. Tables showing the chemical and bacterial analyses of the effluents from these filters and the efficiency of the individual filters and of the various double-filtration systems follow: —

Average Chemical Analyses.

Effluent Filter No. 280.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Deg. F.).	APPEARANCE.		ALBUMINOID.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
17,635,500	53	0.0	.37	.0062	.0156	.36	.021	.0003	.56	58.5	0.9

Effluent of Filter No. 331.

95,561,000	63	0.1	.42	.0034	.0161	.37	.029	.0001	.63	42.6	0.9

Effluent of Filter No. 244.

16,598,300	54	0.0	.30	.0025	.0112	.37	.027	.0000	.48	43.9	1.0

Average Chemical Analyses — Concluded.

Effluent of Filter No. 281.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Deg. F.).	Appearance.		Albuminoid.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
7,016,800	53	0.0	.33	.0036	.0117	.38	.028	.0001	.49	43.6	1.0
Effluent of Filter No. 286.[1]											
7,864,000	48	0.1	.34	.1665	.0215	.93	.057	.0040	.50	6.0	1.5
Effluent of Filter No. 286.[2]											
5,177,800	63	0.0	.04	.0016	.0068	.46	.032	.0001	.21	52.9	1.0

[1] Operated with effluent of Filter No. 219. [2] Operated with effluent of Filter No. 216.

Average Bacterial Analyses.

Filter No. 280.

Applied Water.		Effluent.		Per Cent. of Bacteria removed (Efficiency).
Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	Per Cent. of Samples containing B. Coli.	
2,700	87	360	86.7	84.6
Filter No. 331.				
4,500	210	980	78.2	99.2
Filter No. 244.				
43	-	25	42.0	26.2
Filter No. 281.				
340	23	34	90.0	54.8
Filter No. 286.[1]				
6,200	880	3,700	40.3	100.0
Filter No. 286.[2]				
72	2	17	76.4	6.6

[1] Operated with effluent of Filter No. 219. [2] Operated with effluent of Filter No. 216.

Table showing Percentage Removal of Bacteria by Double-filtration System.

Date.	Lawrence City Filter and Filter No. 218.	Filter No. 220 and Filter No. 244.	Filter No. 280 and Filter No. 281.	Filter No. 219 and Filter No. 286.	Filter No. 216 and Filter No. 286.
1906.					
December,	99.9	98.5	98.2	90.2	–
1907.					
January,	99.6	97.9	98.6	92.3	–
February,	99.8	99.4	98.2	–	–
March,	99.1	99.0	99.1	–	–
April,	99.5	98.8	97.7	95.9	–
May,	–	96.3	97.3	–	–
June,	–	98.5	98.8	–	–
July,	–	99.6	98.5	–	99.2
August,	–	98.9	99.2	–	99.6
September,	–	99.7	99.1	–	99.9
October,	–	98.4	99.0	–	99.5
November,	–	99.3	99.2	–	99.7
Average,	99.6	98.7	98.6	92.8	99.6

MECHANICAL FILTRATION.

Filter No. 216.

This filter, 1/10000 of an acre in area, containing 21 inches of sand of an effective size of 0.71 millimeter, is operated as a mechanical filter, and was first put into operation in 1903. During the first four months of the year attempts were made to use ferrous sulphate as a coagulant. From December 1 to February 9 the filter was operated at a rate of 75,000,000 gallons per acre daily, and copperas and lime were mixed with the applied water in varying proportions. Considerable difficulty was encountered in applying lime in the proper amounts without the use of stirring apparatus in the lime tank, and from February 10 to April 11 caustic soda was used instead, the amount of caustic used being expressed as equivalent lime. From February 10 to February 16 the filter was operated at a rate of 25,000,000 gallons per acre daily, from February 17 to February 25 at a rate of 50,000,000 gallons per acre daily and from February 26 to April 11 at a rate of 25,000,000 gallons per acre daily. The effluent from the filter during the treatment with copperas was never of a satisfactory quality, even when the filter was operated at the comparatively low rate of 25,000,000 gallons per acre daily, and copperas amounting to 6.5 grains per gallon were added. This coincides with the experience elsewhere, that, when treating polluted waters which are soft and comparatively free from turbidity, copperas is much less effectual as a coagulant than is sulphate of alumina.

Filter No. 216A.

On May 14, 1907, the sand in Filter No. 216 was removed and replaced by 24 inches of sand of an effective size of 0.27 millimeter, and from that date until the end of the year the filter was operated at a rate of 75,000,000 gallons per acre daily, the applied water being treated with sulphate of alumina and soda. Operating in this manner, the effluent from the filter was of good quality, but the effect of the finer filtering sand was to decrease the volume of water filtered between washings. Tables showing the results obtained with this filter follow: —

Table showing Rate, Gallons filtered between Washings, and Amounts and Cost of Coagulants.

Filter No. 216.

PERIOD OF OPERATION.	Time between Washings (Hours).	MILLION GALLONS PER ACRE.		CHEMICALS APPLIED (GRAINS PER GALLON).				Cost of Chemicals per Million Gallons filtered.
		Per 24 Hours.	Between Washings.	Copperas.	Lime.	Sulphate of Alumina.	Soda Ash.	
Dec. 1-Feb. 9, . .	26.7	81.4	90.5	2.3	1.6	-	-	$2 36
Feb. 10-Feb. 16, . Feb. 26-Apr. 11, .	39.8	25.9	42.4	4.4	1.3	-	-	3 76
Feb. 17-Feb. 25, . .	18.6	52.0	40.2	4.9	1.2	-	-	4 07
Filter No. 216A.								
May 14-Nov. 30, . .	4.0	74.4	12.3	-	-	2.6	1.4	$5 72

Average Chemical Analyses.

Merrimack River Water applied to Filter No. 216.

[Parts per 100,000.]

PERIOD OF OPERATION.	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS —		Oxygen Consumed.	Hardness.
				ALBUMINOID.						
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
Dec. 1-Feb. 9, . .	0.0	3.8	.0162	.0196	.0179	.43	.022	.0002	.65	1.1
Feb. 11-Feb. 16, . Feb. 26-April 11, .	0.1	3.8	.0149	.0172	.0155	.34	.018	.0003	.59	0.9
Merrimack River Water applied to Filter No. 216A.										
May 14-Nov. 30, . .	0.2	4.5	.0131	.0208	.0176	.36	.016	.0008	.63	1.0
Effluent of Filter No. 216.										
Dec. 1-Feb. 9, . .	0.0	13.7	.0167	.0173	-	.42	.020	.0006	.60	2.6
Feb 11-Feb. 16, . Feb. 26-April 11, .	0.1	19.3	.0114	.0141	-	.30	.017	.0001	.49	0.8
Effluent of Filter No. 216A.										
May 14-Nov. 30, . .	0.0	0.7	.0132	.0089	-	.48	.017	.0006	.21	0.8

Average Bacterial Results.

Filter No. 216.

Period of Operation.	Average Number of Bacteria per Cubic Centimeter.			Average Number of B. Coli per Cubic Centimeter.		Effluent of Filter. Per Cent. of Samples containing B. Coli, 1 Cubic Centimeter.
	Raw Water.	Effluent from Settling Tank.	Effluent from Filter.	Raw Water.	Effluent from Settling Tank.	
Dec. 1-Feb. 9, .	2,200	1,600	1,200	108	72	93.1
Feb. 11-Feb. 16, Feb. 26-Apr. 11,	1,300	950	220	29	12	50.0
Feb. 17-Feb. 25, .	2,100	320	41	62	5	0.0

Filter No. 216A.

May 14-Nov. 30, .	4,400	700	39	131	20	29.9

Removal of Organic Matter and Bacteria.

Filter No. 216.

Period of Operation.	Per Cent. of Organic Matter removed.		Per Cent. of Bacteria removed by			Per Cent. of B. Coli removed by Coagulation and Sedimentation.
	From Albuminoid Ammonia.	From Oxygen Consumed.	Coagulation and Sedimentation.	The Filter.	The System.	
Dec. 1-Feb. 9, .	11.7	7.7	27.3	25.0	45.5	33.4
Feb. 10-Feb. 16, Feb. 26-April 11,	18.0	16.9	27.0	76.8	83.1	58.7
Feb. 17-Feb. 25, .	-	-	84.8	87.2	98.0	91.9

Filter No. 216A.

May 14-Nov. 30, .	57.2	66.7	84.1	94.4	99.1	84.7

Filter No. 317.

This filter, $1/20000$ of an acre in area, was started Oct. 11, 1906, to study the effect of operating a filter containing a considerable depth of sand at a high rate with a very polluted water. During 1907 it contained about 8.5 feet of sand of an effective size of 0.20 millimeter. Canal water, to which was added a varying proportion of strained sewage, was applied at a rate of 7,500,000 gallons per acre daily from December 1 to April 30. On May 1 the rate was reduced to 3,000,000 gallons per acre daily. Although the proportion of sewage mixed with the applied water was reduced from time to time, the bacterial efficiency continued to be very low, and on July 14 the sewage was omitted and the filter was operated with canal water at a rate of 3,000,000 gallons per acre daily throughout the remainder of the year. Operated in this manner, the filter recovered to some extent, but the effluent was never of satisfactory quality. It is evident that the filter was overloaded with organic matter too early in its operation, before bacterial activity had been properly established; and when once such a condition is established the process of biological reconstruction takes place very slowly. The filter was scraped twenty-five times and was out of operation forty-one days during the year.

Average Chemical Analyses.

Applied Water — Filter No. 317.[1]

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Deg. F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
					Albuminoid.							
		Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
-	-	1.4	.50	.4526	.0913	.0736	1.68	0.28	.0025	.95	38.8	2.6
Effluent of Filter No. 317.												
4,167,600	60	0.1	.56	.2181	.0269	-	0.80	.016	.0005	.58	12.3	2.1

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[1] December to July, inclusive.

Average of Bacterical Analyses.

Applied Water.		Effluent.		Per Cent. of Bacteria removed (Efficiency).
Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	Per Cent. of Samples containing B. Coli.	
54,800	12,100	4,600	91.6	74.1

SLOW SAND FILTRATION WITH THE AID OF COAGULANTS.

Filter No. 330.

It is well known that sand filters are effective in removing the bacteria and a certain percentage of the color from the comparatively clear Merrimack River water, but that the residual color of the effluents is often sufficiently high to be objectionable to some consumers. In order to determine what improvement in the appearance of the water would result from treating a water of this type with small amounts of coagulants followed by sedimentation and slow sand filtration, Filter

No. 330 was put into operation on July 8, 1907. This filter is $\frac{1}{10000}$ of an acre in area, and contains 48 inches of sand of an effective size of 0.21 millimeter. The filter was operated at a rate of 5,000,000 gallons per acre daily with canal water, which was treated with 0.25 grain of sulphate of alumina and allowed to settle about nine and one-half hours. Instead of scraping, when the filter became clogged a current of water about 2 inches deep was allowed to flow across the surface and the top inch of sand was stirred up with a rake. The filter was washed in this manner five times during the five months it was in operation. Comparing the effluent from this filter with that from Filter No. 220, constructed of a similar grade and depth of sand and operated at the same rate, we find that the average color removed was slightly less during four of the five months when it was operated than that by Filter No. 220, and that the bacterial removal was also less. The results of chemical and bacterial analyses of the effluent from this filter are given in the following tables: —

Average Chemical Analyses, Filter No. 330.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Deg. F.).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
4,646,600	65	0.0	.35	.0020	.0104	.37	.023	.0005	.52	32.4	1.0

Average of Bacterial Analyses.

APPLIED WATER.		EFFLUENT.		Per Cent. of Bacteria removed (Efficiency).
Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	Per Cent. of Samples containing B. Coli.	
1,100	34	80	92.7	31.3

MAXIMUM RATE DETERMINATIONS.

During the earlier part of the year determinations were made of the maximum amount of water which could be passed through each of the water filters in twenty-four hours. The filters after scraping and raking the surface to a depth of about 1 inch were operated with city water for twenty-four hours with the outlet wide open. After being tested in this manner, samples of sand were taken from various depths in each filter, and determinations of effective size and of the amount of organic matter as loss on ignition were made. It was necessary to make the test on Filter No. 8A with canal water, a sufficient supply of city water not being available, and for this reason the volume of water passed by the filter was probably too low. As a means of comparing the results from the various filters, the maximum rate of each filter has been computed; that is to say, the actual quantity passed by each filter has been corrected to a loss of head equal to the depth of sand and a temperature of 50° F. So far as the data contained in the table show, there seems to be no apparent relation between the quantity of water passed and the amount of organic matter found in the sand.

The volumes passed by Filters Nos. 244 and 286 and 281 were approximately one-half of the theoretical computed volumes for filters of new clean sand; by Filters Nos. 218, 219 and 220, about one-third the theoretical volume; by Filter No. 280, about one-fifth of the theoretical volume; while Filter No. 317 passed less than one-tenth and Filter No. 8 less than one-thirtieth of the theoretical volume. The maximum rates and other data for the various filters are shown in the following table: —

Summary of Maximum Rate Determinations on Experimental Water Filters.

Filter No.	1907.	Period of Service (Years).	Effective Size of Sand.	Depth of Sand (Inches).	Average Per Cent. of Organic Matter in Sand.	Temperature of Water (Deg. F.).	Maximum Loss of Head (Inches).	Million Gallons per Acre per 24 Hours.	
								Actual Quantity of Water filtered.	Corrected Maximum Rate.
219, . . .	March 25,	3.7	0.20	28	0.78	38	76	33.60	9.9
220, . . .	May 3,	3.8	0.20	35	0.73	47	70	21.38	10.2
286, . . .	April 5,	1.2	0.20	41	0.43	50	73	31.62	17.7
218, . . .	April 9,	3.7	0.23	37	0.54	42	74	33.36	14.6
281, . . .	March 21,	1.3	0.23	44	0.48	38	73	18.87	9.1
244, . . .	April 4,	3.2	0.24	37	0.71	42	73	48.24	21.2
317, . . .	March 28,	0.5	0.26	102	0.73	50	142	8.28	6.0
8,[1] . . .	April 18,	0.9[2]	0.28	42	0.79	44	71	3.91	2.1
280, . . .	March 22,	1.3	0.30	6	0.69	38	44	91.43	10.0

[1] Run with canal water.

[2] Refilled May 17, 1906.

Summary of Maximum Rate Runs on Water Filters.

Filter No.	1907.	*Quantity Passed.*[1]	Depth of Sand (Inches).	Size of Sand.	Per Cent. Organic Matter.	Temperature of Water (Deg. F.).	Loss of Head (Inches).	Maximum Rate.	Value of C. (Hazen).
8,[2] . .	Apr. 18,	3.91	42	.28	.79	44	71	2.1	31
218, . .	Apr. 9,	33.36	37	.23	.54	42	74	14.6	339
219, . .	Mar. 25,	33.60	28	.20	.78	38	76	9.9	361
220, . .	May 3,	21.38	35	.20	.73	47	70	10.2	267
244, . .	Apr. 4,	48.24	37	.24	.71	42	73	21.2	460
280, . .	Mar. 22,	91.43	6	.30	.69	38	44	10.0	186
281, . .	Mar. 21,	18.87	44	.23	.48	38	73	9.1	251
286, . .	Apr. 5,	31.62	41	.20	.43	50	73	17.7	415
317, . .	Mar. 28,	8.28	102	.26	.73	50	142	6.0	82

[1] Million gallons per acre daily. [2] Run with canal water.

The maximum rate was computed from the actual quantity passed, corrected to a loss of head equal to the depth of sand and a temperature of 50° F.

EFFICIENCY OF FILTERS COMPUTED FROM COUNTS AT 40° C.

During 1907, in addition to counts of the numbers of bacteria developing on agar plates incubated four days at 20° C., counts were made of the numbers developing on litmus-lactose-agar plates incubated for eighteen hours at 40° C., and of the number producing acid-fermentation of lactose on these plates. In polluted waters, such as the Merrimack River, and in sewages and the effluents from sewage filters, this latter acid-fermenting type has usually been called B. coli, and this designation is retained in the following table, although, strictly speaking, all of the organisms included by this classification are not true B. coli. The significance of the 40° C. counts was discussed in the report of the Board for 1906 (pp. 325 to 349, inclusive). It has been usual in the past to express the efficiency of filters in removing bacteria in terms of the 20° C. bacteria, and the significance of such efficiencies is well understood. The efficiencies obtained from the 40° C. counts vary materially from the usual 20° C. efficiencies; and for this reason, and because the presentation of other and different efficiency results in the preceding tables would possibly lead to confusion, these various efficiencies and the bacteriological data from which they are derived are given separately.

There are two principal advantages to be obtained by using the 40° C. counts. Counts on plates incubated at 40° C. may be obtained in eighteen to twenty-four hours, while by the usual procedure the results are not available until three to four days after the sample is plated; and for this reason it is much easier to keep in touch with the operation of filters and to locate and correct filter troubles earlier than has been possible under the older practice. Furthermore, the types of bacteria growing rapidly at 40° C. are very largely sewage types, in whose removal by filtration we are primarily interested; and, so far as we know, these types never multiply within the filters or in any of the tanks and reservoirs connected with filtration systems, while the reverse is frequently true with the ordinary types of water bacteria.

Speaking generally, it has usually been assumed that the number of bacteria in good filtered water should be less than 100 per cubic centimeter, and that the efficiency of a filter when operated with a water similar to the Merrimack River water should be at least 98 per cent., — the reason for this assumption being that formerly only badly polluted water was filtered. When filtering a comparatively clean water, the number of bacteria in the effluent of the filter should, of course, be much less than 100 per cubic centimeter, although the percentage efficiency might not be so great. When filtering badly polluted water, the number of bacteria of the 40° type in the filtered water should be usually below 10 per cubic centimeter and the number of B. coli should not be more than 5 per cubic centimeter, while the percentage removal of these two types should be over 90 per cent., but is seldom found to be as high as that computed from the total bacteria. For example, the total bacterial removal by the Lawrence city filter for the year 1907 was 99.3 per cent., while the removal of 40° C. bacteria and of B. coli was 95.7 and 96.7 per cent., respectively. The results obtained from Filters Nos. 8 and 220 were similar to those obtained from the city filter. Operating with waters containing smaller numbers than the Merrimack River, the number of bacteria in the filtered water should be considerably less than 100 per cubic centimeter; but the efficiency may also be much less than the figure stated, owing to small numbers in the applied water. On the other hand, in the case of secondary filters in double-filtration systems the percentage removal of the 40° types is frequently greater than is the total removal, indicating, of course, that our total bacteria counts have been influenced by growths of harmless forms within the filters. Filter No. 218, which received Lawrence filtered water, showed a total bacteria removal of 18.8 per cent., while the removal of total 40° bacteria and of B. coli was 60 and 50 per cent., respectively; and Filter No. 244, which received the effluent from Filter No. 220, showed a total efficiency of only 42 per cent., although the removal of 40° bacteria and of B. coli was 50 per cent., respectively. The average numbers of total bacteria, 40° bacteria and B. coli and the efficiencies of the various filters computed from those numbers for 1907 are shown in the following table: —

Table showing Average Counts of Bacteria at 20° C. and 40° C., and the Efficiency of the Various Filters computed from those Counts.

	Applied Water.			Effluent.			Per Cent. removed.		
	Bacteria per cubic centimeter.		B. Coli per Cubic Centimeter.	Bacteria per cubic centimeter.		B. Coli per Cubic Centimeter.	Bacteria.		B. Coli.
	20° C.	40° C.		20° C.	40° C.		20° C.	40° C.	
City filter, . . .	2,700	140	90	19	6	3	99.3	95.7	96.7
Filter No. 8, . .	2,700	130	87	33	11	4	98.8	91.5	95.4
Filter No. 216,[1] . .	800	80	22	43	6	3	94.6	92.5	86.3
Filter No. 218, . .	16	5	2	13	2	1	18.8	60.0	50.0
Filter No. 219, . .	49,000	5,200	4,000	10,600	2,500	2,200	80.8	52.0	47.5
Filter No. 220, . .	2,700	130	87	48	11	6	98.2	91.5	93.1
Filter No. 244, . .	43	14	6	25	7	3	42.0	50.0	50.0
Filter No. 280, . .	2,700	130	87	360	42	24	86.7	67.7	72.4
Filter No. 281, . .	340	38	23	34	12	7	90.0	68.4	69.6
Filter No. 286,[2] . .	2,400	410	330	1,300	235	190	45.8	42.6	42.4
Filter No. 317, . .	54,800	14,600	12,100	4,600	1,000	810	91.6	93.2	93.4
Filter No. 330, . .	1,100	55	34	80	13	3	92.7	76.4	91.2
Filter No. 331, . .	4,500	320	210	980	65	50	78.2	79.7	76.2

[1] May to November, inclusive.

[2] Double-filtration period only.

REPORT

UPON THE

CHEMICAL EXAMINATION OF DRAWN AND UNDRAWN POULTRY KEPT IN COLD STORAGE.

By WILLIAM F. BOOS, Ph.D., M.D.

REPORT UPON THE CHEMICAL EXAMINATION OF DRAWN AND UNDRAWN POULTRY KEPT IN COLD STORAGE.

By William F. Boos, Ph.D., M.D.

The questions involved in this research are: —

(1) Does the meat of fowl in cold storage undergo chemical changes which produce poisonous substances?

(2) In case such changes occur, in which class of birds, the drawn or the undrawn, are the changes more marked?

(3) If no changes occur during cold storage, which of the two kinds, drawn or undrawn, taken from the storage warehouse and exposed to ordinary temperature, will more quickly undergo bacterial changes involving the formation of poisonous substances?

(4) How do properly drawn, ordinarily drawn, and undrawn, freshly killed fowl compare in keeping qualities on exposure to ordinary temperature?

The poisonous substances which may form in meat in consequence of putrefaction have been included in a special class. A second class includes those produced in apparently wholesome meat by bacterial invasion.

This division will probably in time be abandoned, because there is really no fundamental difference between the two. When ordinary putrefaction takes place, various organisms are at work, and it has not been possible so far to trace each of the many products formed to the organism which produces it; but while some of these products are harmless, others are as intensely poisonous as those produced by the most virulent of pathogenic bacteria. Some of the poisonous substances produced during putrefaction represent intermediate products. They are changed by further bacterial action into simpler chemical bodies, which are but slightly toxic or even harmless.

Such changes occurring in the putrefying material explain the fact that the intensity of action shown by a putrefied solution given intravenously to an animal is in no constant relation to the quantity of liquid injected, but varies steadily with the advancement of putrefaction. There is a point of time when the solution reaches the height of its virulence; from this time forward it gradually decreases in toxicity, until finally the solution becomes inactive. Certain chemical reagents, as well as boiling and baking, produce similar changes from toxicity to harmlessness.

The term "ptomaines" was first used by Selim, who employed it as a collective term for a number of basic substances obtained from cadavers and related chemically and physiologically to vegetable alkaloids, such as coniine, morphine and atropine. Brieger[1] kept the name, but applied it to those basic substances only which are produced by the life processes of bacteria. He classed, under the head of ptomaines, a great number of substances which he and others succeeded in isolating from the putrefied flesh of mammals, fish and mollusks, or from unputrefied animal products which had given rise to poisoning.

As a matter of fact, the great majority of the so-called ptomaines are non-toxic, or less toxic than ammonia. Brieger's ptomaines include, moreover, substances which are chemically very different; the classification is not a scientific one, and is being abandoned. Even at the time of Brieger's investigations it was found necessary to distinguish between poisonous and non-poisonous ptomaines, and on this account the term "toxines" was introduced as a distinguishing name for poisonous bacterial products.

It was found that some of these toxines could be obtained from bacterial culture fluids, from which the bacteria themselves had been removed by filtration. The toxines were precipitated from solution together with proteid products of bacterial life; and therefore these toxine precipitates and their solutions gave typical proteid tests. But upon further purification, solutions of the toxines were obtained which were free from all proteid matter. In fact, all the bacterial, animal and vegetable poisons which have thus far been isolated in a comparatively pure state are free from albumin. The statement, therefore, that certain substances called toxalbumins are formed as a result of bacterial activity or of animal or vegetable metabolism, remains still to be proved.

Because of present lack of definite chemical knowledge concerning these bacterial poisons, the poisonous substances obtained from bacterial culture fluids free from bacteria have been crudely classed as ectotoxins.

The action of the ectotoxins resembles closely the symptoms produced by infection with the bacteria themselves. The toxines of this class have furthermore many properties chemically and physiologically analogous to the properties of poisons belonging to the ricine-group, to ophiotoxine or snake venom, and to the poisons of certain spiders, scorpions, etc. Like these substances, they are extremely sensitive to physical and chemical influences. Air, direct sunlight, heat from 50° C. upward, acids and alkalies, reduce their activity. They may, however, be dried, and in the dry state may be heated to 100° C. for a short period, without losing their activity. Their importance for practical medicine lies in the fact that the intravenous injection of small quantities of these ectotoxins produces antitoxins. Among the bacteria which produce ectotoxins are several of the staphylococci and streptococci, the diphtheria bacillus, the *bacillus botulinus* and the bacillus of tetanus.

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[1] Untersuch. über Ptomaine. Berlin, 1885–6.

The second group of bacterial poisons, known as endotoxins, is obtained from the bodies of the pathogenic bacteria themselves. These toxines are not found in the culture fluid; they seem to be more or less firmly bound to the bacterial cells, and they are obtained as part of the body substance of the bacteria after sterilization of the cultures. The important difference between these and the ectotoxins lies in the fact that, when the endotoxins are injected into the blood or subcutaneous tissue, they do not, like the ectotoxins, produce genuine antitoxins, but precipitating and agglutinating anti-bodies, the so-called "precipitines" and "agglutinines." From many bacteria, among them the bacillus of tuberculosis, the *bacillus pyocyaneus* and the *staphylococcus pyogenes aureus,* both ectotoxins and endotoxins have been obtained. The opsonines of Wright are produced by the injection of endotoxins. Among the bacteria, the toxic action of which is due chiefly to endotoxins, are *bacillus enteriditis* of Gaertner and *bacillus coli communis.*

A large proportion of all meat-poisoning cases is due to bacterial infection. The symptoms noted vary considerably according to circumstances, since they may be caused by a variety of bacterial poisons having very different pharmacological action. Many of the cases, moreover, may be due to mixed infection.

Some of these bacterial toxines show effects very similar to those of the vegetable alkaloids, and on this account they have been called animal or bacterial alkaloids. Such alkaloidal action is often very definite in cases of so-called sausage poisoning or botulism. *Bacillus botulinus* was first isolated and studied by Van Ermengem, who found innumerable spores of this organism in a ham which was apparently perfectly wholesome, but which had caused a large number of cases of severe poisoning. He also found the organism in the spleen of one of the victims. Pharmacologically, the symptoms of botulism resemble closely those of atropine poisoning, and the active agent in these cases has therefore been called "ptomatropine."

Among the organisms which have been more frequently found in meat and fish apparently fit for consumption, and the poisons of which have produced more or less characteristic symptoms, are *bacillus enteriditis* of Gaertner, *bacillus coli,* and, above all, *bacillus paratyphosus,* B.

From time to time, investigators have claimed to have obtained so-called thermo-stabile toxines from meat or fish material which had given rise to poisoning. This claim has been asserted in reference particularly to botuline and the toxine produced by *bacillus paratyphosus,* B. Neisser, an authority on the bacteriology of meat-poisoning, denies the existence of thermo-stabile toxines. According to him,[1] those claiming to have obtained such thermo-stabile bacterial toxines have not in a single instance obtained results which were above criticism. In support of Neisser's position, it must be borne in mind that in the ordinary processes of cooking, the temperature reached in the interior of a fairly large joint or fish is considerably below 100° C., and is at times not above 50° C. Consequently, both the bacteria, and the toxines they have produced in the interior of a piece of meat, may be unaffected when the meat is ready for the table. The coating of coagulated and seared albumin, which forms quickly on roasts acts as a very poor conductor of heat, and on this account the center of a roast may be almost raw when the meat appears to be cooked.

The only bacterial poison which has been isolated in the pure state is sepsine, the poison of putrefaction. In his memoir, published eighty-five years ago, Gaspard[2] showed that there is a well-characterized putrid or septic infection, in which the symptoms are produced by a septic or putrid poison which occurs constantly in putrefying organic matter. Gaspard also showed that the volatile foul-smelling decomposition products play no part in the poisoning. Some thirty years later, Panum[3] proved by his investigations that the toxic substance in putrefying animal material acts independently of the bacteria present. Following the advice of Dragendorf, Bergman[4] and others used putrid yeast as a material for the preparation of the putrefactive poison. Bergman turned over his very active material to Schmiedeberg,[5] who succeeded in isolating therefrom an alkaloid, the action of which was identical with that of solutions obtained from putrid meat. Several years ago, Faust[6] succeeded in obtaining sepsine in the pure state in sufficient quantity carefully to study its action as well as to determine its chemical composition. Faust prepared sepsine from both putrefied yeast and blood. He found this substance to be a most powerful poison: 20 mg. of the sulphate, containing only 11.5 mg. of the free base, given intravenously, caused death in a large dog within a few hours. Death seemed to be due to an action very similar to that of arsenic, which, by poisoning the intestinal capillaries in a peculiar manner, causes a most intense hyperæmia and consequent diarrhœa, ending with copious stools of pure blood. It is especially important to note that sepsine does not cause inflammatory changes of the intestinal mucous membrane.

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[1] Personal statement to the writer.

[2] Gaspard. J. de Physiol. tome II. 1822; tome IV. 1824.

[3] Panum. Virchows Arch. Bd. LX., 301, 1874.

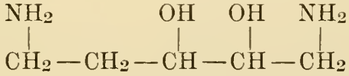
[4] E. Bergman. Dorpat, 1868 (Diss.).

[5] Centralbl. f. d. M. W. 1868, 497.

[6] Faust. Arch. f. exp. Path. u. Phar. 43, 229; 41, 84; 47, 1.

Sepsine is very unstable, a solution of sepsine or its sulphate is rendered inactive by heating for a short time at 60° on the water-bath. From the inactive residue Faust obtained a precipitate with platinic chloride, which proved to be the chlorplatinate of pentamethylendiamine, called *cadaverine* by Brieger. This same cadaverine is the best-known so-called ptomaine; its presence indicates that the solution containing it has at one time contained sepsine, which by a process of reduction has been changed into cadaverine. Putrescine, tetramethylendiamine, is probably derived from an analogous mother substance which at present is unknown.

For sepsine Faust obtained analytical figures which yielded the following formula: $C_5H_{14}N_3O_2$, or, structurally expressed,



$$\begin{array}{ccccccccc} NH_2 & & & & OH & & OH & & NH_2 \\ | & & & & | & & | & & | \\ CH_2 & - & CH_2 & - & CH & - & CH & - & CH_2 \end{array}$$

Poisoning by spoiled meat is primarily sepsine poisoning. But sepsine is easily transformed by heat into innocuous cadaverine. On this account, spoiled meat, and even such as is far gone in decomposition, probably will not cause poisoning if it has been thoroughly cooked. This is known to be true of meat infected with Gaertner's *bacillus enteriditis,* the endotoxin produced by this organism being destroyed by heat. The truth of this has been well established by the records of numerous epidemics of meat-poisoning due to Gaertner's bacillus, in which only those persons fell victims who ate the meat raw, smoked, or not thoroughly cooked.

In my investigations, I subjected the meat from the different birds to a process which ended all bacterial activity in the promptest manner possible. Such a process was rendered necessary by the primary object of the investigation, which was to determine the effect of cold storage from a hygienic point of view on the two kinds of poultry. The process necessary to isolate sepsine requires several days' to a week's exposure of the material under investigation to ordinary temperature. Such exposure would of course lead to extensive secondary changes due to bacterial activity. But since it is well established that cadaverine is formed from sepsine, the isolation of cadaverine from the food material establishes beyond a doubt that this material has been in a state of decomposition with the formation of substances most detrimental to health.

In my work, therefore, I have used the presence of cadaverine and putrescine as indications of the degree of decomposition. Some changes occur in animal tissues within a few hours of the animal's death, due not only to bacterial action but also to the antolysis of the tissues, and since these changes must be very extensive to lead to the formation of sepsine and cadaverine, the presence of the latter is an indication only of gross putrefaction, and cannot be used as a delicate measure of slight tissue decomposition changes far removed as yet from putrefaction. Such a method of comparison applicable to the matter in hand is not to be found in the literature. On this account, I devised a method of my own, which is described in the experimental part of these records, and which I applied more particularly to the study of the comparative keeping quality of drawn and undrawn freshly killed fowl.

I append an outline scheme of the investigation. The material used consisted of poultry which had been kept in cold storage for periods ranging from four to ten months.

I.

An investigation to determine the presence of so-called ptomaines, especially cadaverine, which would indicate that the materials under observation had at one time contained bacterial poison (sepsine), —

A. — By Brieger's method.

B. — By the method of Baumann and von Udránszky.

II.

In case of negative results from I., experiments to determine the possible presence of any of the typical products of bacterial decomposition, using the method of E. and H. Salkowski.

III.

Experiments on the living animal, consisting of subcutaneous and intravenous injections of extracts from drawn and undrawn poultry in cold storage, and from poultry bought in the open market.

IV.

Experiments in which drawn and undrawn cold-storage fowl were exposed for several days to ordinary temperature, as a measure of their comparative keeping qualities.

V.

Experiments in which drawn and undrawn freshly killed fowl were exposed as in IV.

I.

A. — Examination for Ptomaines according to Brieger.

Exp. 1. — Three drawn fowls were placed on the water-bath. After about five hours' exposure to water-bath temperature, they were completely thawed. The meat from the breast, back and legs was dissected from the carcass, freed from fat, then finely minced by a meat-chopper, and covered with water in a large porcelain dish. The contents of the dish were acidulated with hydrochloric acid, and then heated on the water-bath. After several hours' heating, the meat and coagulated proteids were removed by filtration and the residue thoroughly washed with distilled water. The united filtrate and wash-waters, a clear, straw-colored fluid, free from fat, was evaporated on the water-bath to a syrupy consistency, and then extracted with absolute alcohol. Under these conditions all ptomaines should go into solution, and the proteids and salts remain. The extraction of the residue was repeated until a colorless extract was obtained. The gradually increasing concentration of the alcoholic solution caused a secondary separation of proteids from the solution, in the form of a white, flocculent precipitate. The filtered alcoholic solution gave a slight biuret test. It was evaporated to a syrup on the water-bath, and again extracted with alcohol. This process was repeated several times, but it was not possible in this manner to obtain a solution free from bodies yielding the biuret test. The clear, slightly yellowish alcoholic solution was precipitated with an alcoholic solution of mercuric chloride. A voluminous, white, flocculent precipitate was formed, which settled readily, and on standing assumed a lemon-yellow tint. After twenty-four hours' standing, the precipitate was collected on a filter and washed with alcohol, until the alcoholic wash-water was colorless. The precipitate was freed from alcohol by pressing it between layers of filter-paper, transferred to a flask and boiled for a long time with an excess of distilled water. The supernatant liquid was filtered hot, and the undissolved residue boiled with three successive portions of distilled water. The united filtrates were allowed to stand for twenty-four hours. Under these conditions, the double chloride of cholin and mercury, if present, is precipitated. The solution showed, however, no trace of precipitate or turbidity, therefore cholin, the presence of which would indicate a bacterial decomposition of lecithin from muscle, was absent. The undissolved residue contains chiefly proteid compounds of mercury, while ptomaines, if present, are contained in the aqueous extract in the form of double chlorides with mercury. The aqueous solution was treated with sulphuretted hydrogen to complete the precipitation of the mercury, the excess of sulphuretted hydrogen was removed by a current of air, and the solution freed from sulphide of mercury by filtration. The almost colorless filtrate was evaporated to syrupy consistency on the water-bath, and extracted repeatedly with alcohol. Cadaverine, if present, goes into solution, while putrescine remains undissolved. The alcoholic solution was allowed to stand twenty-four hours, so that any possible traces of putrescine hydrochloride in solution would crystallize out. No precipitate of any sort was formed. Part of the solution was then treated with platinic chloride solution. Cadaverine, if present, should be precipitated in the form of the crystallized double chloride with platinum. There was, however, no precipitate or even turbidity after long standing. To confirm the absence of cadaverine, other tests were made. A part of the solution was treated with a few drops of a concentrated solution of picric acid, and no precipitate was formed. Cadaverine, if present, would appear as an insoluble crystallized precipitate. To another portion of the solution a few drops of a solution of iodine in potassic iodide were added; no precipitate was formed. Cadaverine, if present, is precipitated in the form of brown needles. The residue from the alcoholic extract, which contains muscle extractives such as urea, lecithine, soaps, creatinine, etc., was dissolved in a little water, and the solution shaken with sodium hydrate and benzoyl chloride until the smell of the latter disappeared. A very slight white precipitate which was formed was collected on a filter, washed thoroughly with water, and after being dried superficially, dissolved in a little warm alcohol. The alcoholic solution was poured into an excess of ether. No precipitate was formed; therefore, putrescine, the compound of which with benzoyl chloride is insoluble in ether, was absent.

Exp. 2. — Three undrawn fowls were divested of all their meat, as described in Exp. 1, and the same treatment was given the meat as in that experiment. The results of all the tests for ptomaines were negative.

Exp. 3. — All the meat of four drawn fowls was treated as in Exp. 1. In this experiment, again, all tests for ptomaines were negative.

Exp. 4. — All the meat of four undrawn fowls was treated as described in Exp. 1, and the extracts tested for the presence of ptomaines, as described above. All the tests proved negative.

Exp. 5. — All the meat of three drawn fowls was finely chopped, as in Exp. 1, and treated directly with an excess of alcohol acidified with hydrochloric acid. The extraction with alcohol was repeated three times; the united extracts were freed from alcohol by distillation, and the residue filtered from fat and evaporated to a syrupy consistency. This residue was treated farther as described in Exp. 1. In this case, too, the tests for ptomaines all proved negative.

Exp. 6. — All the meat of three undrawn fowls was treated directly with alcohol, as described in Exp. 5. The final extracts yielded negative tests for ptomaines.

Exp. 7. — The united giblets (gizzards and livers) of eight of the drawn birds were treated as described in Exp. 5. The final extracts gave negative tests for ptomaines. In this case, as well as in Exp. 8, the quantity of extractive matter precipitated by mercuric chloride and soluble in boiling water was greater than in the case of muscular tissue.

Exp. 8. — The final extracts of the giblets of eight of the undrawn birds gave negative tests.

INVESTIGATION FOR PTOMAINES BY THE METHOD OF BAUMANN AND VON UDRÁNSZKY.

Exp. 9. — All the meat of three drawn fowls was freed from fat, finely chopped and extracted four times with an excess of alcohol containing a trace of sulphuric acid. The united alcoholic extracts were evaporated to syrupy consistency on the water-bath, and the syrup was then treated with about 1500 c.c. of cold water. The fats separated from the solution and were removed by filtration. Then 200 c.c. of a 10 per cent. solution of sodium hydrate and 25 c.c. benzoyl chloride were added to the clear filtrate in a flask, and the contents of the flask were then shaken until the odor of benzoyl chloride disappeared. A grayish sandy precipitate was formed. This was collected after twenty-four hours, surface dried, and extracted with hot alcohol, in which it seemed to be quite insoluble. The colorless alcoholic extract was evaporated to a small bulk, and then poured into thirty times its own volume of distilled water. A very slight turbidity occurred, but no precipitate was formed, not even after long standing. The aqueous solution filtered from the original benzoyl chloride precipitate was strongly acidified with sulphuric acid, and repeatedly extracted with ether by shaking. The ethereal extract was evaporated and the residue treated with sodium hydrate in excess. After several days' standing, no crystals formed; therefore, neither the benzoyl chloride precipitate nor the aqueous solution contained ptomaines.

Exp. 10. — Three undrawn fowls were divested of all their meat, and the meat, together with the giblets, was treated as in Exp. 9. In this case also no precipitate of ptomaines was obtained.

Exp. 11. — Three drawn fowls were subjected to the process described in Exp. 9, and in this case, again, negative results were obtained in the tests for ptomaines.

Exp. 12. — All the meat from three undrawn fowls was extracted as described in Exp. 9, and the extracts tested for ptomaines. The result was negative.

Exp. 13. — All the meat of three drawn ducks was extracted with alcohol and treated further as described in Exp. 9. The tests for ptomaines were negative.

Exp. 14. — All the meat from three undrawn ducks was treated as described in Exp. 9. The final tests for ptomaines were negative.

Exp. 15. — All the meat and the giblets of three drawn ducks were treated according to Exp. 9. The tests for ptomaines were negative.

Exp. 16. — All the meat and the giblets from five undrawn ducks were treated according to the method described in Exp. 9. Again the tests for ptomaines gave negative results.

Exp. 17. — All the meat of two undrawn chickens, bought in the public market, was treated as described in Exp. 9. The final tests for ptomaines were negative.

II.

In order to determine if any of the typical bacterial decomposition products had been formed in sufficient quantity to be detected, several tests were made.

Exp. 1. — All the meat from three drawn fowls was finely chopped, transferred to a five-liter round-bottomed flask, and mixed with about three and one-half liters of distilled water. The contents of the flask were then distilled, the distillation being continued for several days. The water in the flask was renewed from time to time. In this way about four liters of a distillate consisting of a slightly turbid, colorless liquid, having a few fat drops on its surface and a strong and agreeable odor of chicken broth, were obtained.

The distillate was acidified with hydrochloric acid and shaken out in portions of about one liter with one-half liter of ether. The ether takes up indol, skatol, phenols and acids, if they are present. To remove any possible phenols and acids, the ethereal solution was twice thoroughly shaken with sodium hydrate solution. The ethereal solution was separated from the aqueous solution of sodium hydrate (*a*) and evaporated. The residue from evaporation was treated with sodium hydrate and distilled in a current of steam. Indol and skatol, if present, would pass into the distillate, while remaining traces of phenol and cresol would remain in the flask. The distillate with steam was shaken repeatedly with the same portion of ether. Indol and skatol, if present, would pass into the ether. On evaporation, the ether left merely a trace of residue, which treated with water appeared to be insoluble. The colorless aqueous extract was divided into two parts, one to be tested for indol, the other for skatol. Half of the first portion was acidified with a few drops of nitric acid, and a few drops of a .02 per cent. solution of potassium nitrite were added. The solution remained colorless and clear. In the presence of indol, a red color would be formed, while skatol would cause the solution to become turbid. The other half of the first portion was treated with sodium nitro-prusside until a yellow color was produced, and then a few drops of sodium hydrate solution were added. There was no change of color. The negative result of these two tests proved the absence of indol.

The yellow solution was treated with glacial acetic acid in excess. There was no change of color to violet, therefore the test for skatol was negative. A part of the second portion of the aqueous extract was treated with concentrated hydrochloric acid. There was no change of color; a negative test for skatol. The remainder of the second portion of aqueous extract was warmed with concentrated sulphuric acid; there was no color change. Skatol, if present, under these circumstances would cause the formation of a deep purple color.

The sodium hydrate solution (*a*) remaining after shaking the original ethereal solution with alkali was united to the residue remaining in the flask after distillation with steam. The combined solutions were saturated with carbon dioxide and distilled. A little of the distillate was treated with a few drops of ferrous chloride solution. There was no change of color. Phenol and cresol, if present, would cause the formation of a violet color. Another portion of the distillate was boiled with Millon's reagent. There was no color change. Phenol and its derivatives would cause, if present, the formation of a red color or precipitate. Still another portion of the distillate was treated with a few drops of bromine water; there was no change whatever. Phenol and its derivatives yield a yellowish crystalline precipitate of tribromphenol. This is a very delicate test.

Exp. 2. — The entire meat of three undrawn fowls was treated with water, the mixture distilled, and in fact the whole process as described in Exp. 1 repeated. In this case, too, the tests for indol, skatol, phenol and cresol were absolutely negative.

Exps. 3 and 4. — The process was repeated once with three drawn and three undrawn fowls, respectively. Results, negative.

III.

In order to study the question of toxicity on living animals, a series of experiments was made in which extracts of both drawn and undrawn fowl were given intravenously to rabbits. In some cases the quantity of the extract or its consistency was such that the extract had to be given subcutaneously.

Exp. 1. — All the meat of two drawn fowls was finely cut in the meat-chopper, and extracted completely with alcohol to which a trace of hydrochloric acid had been added. The combined alcoholic extracts were freed from alcohol by distillation, and the residue from distillation evaporated to a syrupy consistency. The syrup was taken up with a little water, and the solution filtered to remove the undissolved fats. The filtrate was carefully neutralized with sodium carbonate, and evaporated to a syrup. The syrup was taken up with alcohol to complete extraction, the alcohol removed by evaporation and the remaining dark-brown syrupy residue dissolved in the smallest possible bulk of water. The resulting liquid was too concentrated for intravenous injection, and on this account it was given to a rabbit subcutaneously. The animal showed no reaction whatever to the liquid injected.

Exp. 2. — All the meat from two drawn fowls was treated in the manner described in Exp. 1. In this case, however, care was taken that the temperature of the water-bath was kept much lower, and in this manner extensive caramelization was prevented. The syrupy residue was extracted many times with small amounts of absolute alcohol, evaporation and extraction alternately with alcohol and water being repeated until a solution of small bulk was obtained. The neutral aqueous solution, amounting to about 5 to 6 c.c., was injected into the vein of the rabbit's ear. The animal showed no reaction.

Exp. 3. — Two undrawn fowls were prepared as in Exp. 2, and an aqueous extract was made for injection. The quantity of the extract, more than 20 c.c., was divided into two somewhat unequal portions; the larger was injected subcutaneously, while the smaller was given directly into the two ear-veins. The animal showed no reaction.

Exp. 4. — An extract was made from all the meat and the giblets of two fowls bought in the public market. The fowls did not look very appetizing, and emitted a slight odor of decomposition. In this case even greater care was taken to prevent over-heating of the alcoholic and aqueous solutions. An aqueous extract was obtained which was only slightly colored, but the quantity of which exceeded 50 c.c. Desiring to give the whole amount of liquid directly into the blood, the rabbit was placed on a board and the largest vein of the left leg was prepared by tying a steel canula into the vein. The solution was allowed to flow into the vein from a burette. After the injection the rabbit was somewhat collapsed, probably, however, on account of a slight operative shock. In the course of two hours he recovered completely.

Exp. 5. — The meat from two undrawn fowls was prepared in the usual manner. The aqueous extract was rather large in amount. Therefore, wishing to avoid the shock of the operation on the vein of the leg, the liquid was divided into two parts, and one half was injected into the veins of the ear and the other half subcutaneously. No reaction.

Exp. 6. — The aqueous extract obtained from two undrawn ducks, prepared as described in Exp. 2, was injected into the veins of the ears. The animal showed no reaction.

Exp. 7. — The aqueous extract obtained from the meat of two drawn ducks, according to the method described in Exp. 2, was injected intravenously into a rabbit. The animal remained normal.

Exps. 8 and 9. — The aqueous extracts of two drawn and two undrawn ducks respectively were given intravenously to rabbits without reaction.

IV.

To study the comparative keeping qualities of the drawn and the undrawn fowls, three birds of each kind were thawed at room temperature (68° F.), and then exposed in the same room to constant temperature (68° F.) for six days. Before the end of this time the drawn birds had broken down badly, while the undrawn had kept comparatively well. On the sixth day the peritoneal cavity of the drawn birds presented a most nauseating sight. It was half filled with a dark, putrid, semi-liquid mass, having a most foul odor. All the joints of the birds were loosened by putrefaction, so that they could be opened with very little effort. The undrawn birds were considerably inflated with intestinal gas, but their external appearance was much superior to that of the drawn specimens. When the peritoneal cavity of the undrawn birds was opened, it was found to emit a stale, somewhat sour, but certainly not putrefactive, odor. The joints of the birds were in good condition.

Exp. 1. — All the meat of the drawn birds from the breast, lower part of back and legs was taken and prepared as in Exp. I., B. 1, *i.e.*, for investigation by the benzoyl chloride method. The meat near the neck was rejected on account of its badly decomposed state. While the meat was being worked up in the laboratory, and even while the alcoholic solutions were being evaporated, the atmosphere of the room was almost unbearable. The original alcoholic residue was taken up with a small quantity of water, and about one-fourth of the solution preserved for animal inoculation. The remainder was converted according to the method mentioned above. The original benzoyl chloride precipitate was dissolved in alcohol, and the alcoholic solution diluted with 600 c.c. of water yielded considerable of a finely flocculent precipitate. This was collected, thoroughly washed with water, dried, dissolved in alcohol and again diluted with an excess of water. A precipitate of fine, colorless needles was gradually formed. This precipitate of benzoyl derivatives of ptomaines was collected on a filter, washed, dried and redissolved in the smallest possible quantity of alcohol. The alcoholic solution was practically colorless. To determine if the precipitate had consisted of both cadaverine and putrescine, or of cadaverine alone, the alcoholic solution was poured into twenty times its volume of ether. Under these conditions benzoyl-putrescine, which is insoluble in ether, crystallizes out, while benzoyl-cadaverine remains in solution. No precipitate was formed, therefore the substance in alcoholic solution was benzoyl-cadaverine alone. A considerable quantity of cadaverine could also be isolated from the original solution containing benzoyl chloride in excess.

Exp. 2. — The undrawn birds were worked up in precisely the same manner as the drawn, care being taken to select the same meat as in the first case. In this case the odor while the birds were being worked up, although not pleasant, was not very disagreeable. The alcoholic solutions emitted no disagreeable odor whatsoever during evaporation. In the final test for ptomaines a very slight amount of precipitate was obtained, the test being so faint as to be almost doubtful.

Exps. 3 and 4. — Extracts of both the drawn and undrawn birds, which had been kept for this purpose and which were prepared for animal inoculation according to the method described in III., Exp. 2, were given intravenously to rabbits. Although the animals did not appear quite normal immediately after the injection, they recovered very quickly, and then showed no further reaction. Evidently the sepsine which had originally been present in the two classes of fowl, but especially in the undrawn birds, had been completely inactivated by the chemical processes necessary to prepare the injection fluid.

V.

In order to study the comparative keeping qualities of freshly killed fowl in the drawn and undrawn condition, a simple method was used to determine the total decomposition products formed in a given time, without isolating the individual substances present. By this method the products of autolysis of the tissues and those obtained as a result of bacterial decomposition may include leucin, tyrosin, tryptophane, glycocoll, other amido-acids, mono- and diamines and glucose.

The products of autolysis are quantitatively the same per gram of tissue for both kinds of birds exposed the same length of time. The total quantity of bacterial products depends not only on the length of exposure, but on the preparation of the birds exposed.

The fowl exposed formed three categories: (*a*) fowl freshly killed and properly drawn; (*b*) fowl freshly killed and drawn in the usual way; (*c*) fowl freshly killed but left undrawn.

In each case the total muscle tissue, with the exception of the abdominal muscles, was removed, passed through the meat cutter and extracted five times with 95 per cent. alcohol. The united alcohol extracts were filtered, and the greater part of the alcohol recovered by distilling the filtrate. The residue from distillation was taken up with water and heated on the water-bath to remove the last traces of alcohol, the water being renewed from time to time. During this process the fats dissolved in the alcohol separate completely, and may be removed from the cold aqueous solution by filtration. At times it is not possible in this way to remove all the fat, the fluid not yielding a clear filtrate. In such cases the addition of a little barium hydrate solution precipitates the fats and allows a clear filtrate to be obtained. The excess of barium is removed from the filtrate by careful neutralization with sulphuric acid. The filtrate from the barium sulphate precipitate, or the solution to which it was not found necessary to add barium hydrate, is made up with water to about 1500 c.c.; 200 c.c., 10 per cent. sodium hydrate and 25 c.c. benzoyl chloride are added, and then the mixture is shaken in a stoppered flask until the odor of benzoyl chloride has disappeared. After standing twenty-four hours, any crystalline, white precipitate which may have formed is collected on a filter, washed with water until the filtrate is neutral to litmus paper, and dried. The filter and precipitate are extracted five times with hot alcohol, and the united extracts evaporated to a small bulk. The concentrated alcoholic solution is made up to exactly the same volume (about 25 c.c.) for birds of one series, and is poured into thirty times its volume of water. The resulting opalescence or turbidity will vary in exact proportion to the total quantity of decomposition products present, and may be determined as to its intensity by the amount of the respective solution required to obliterate a series of black marks on a glass disc placed at the bottom of a tall glass cylinder.

Series A.

One bird, fresh-killed and drawn in a practically sterile manner as follows: a boiled string is attached to the gullet below the crop. The gullet above the string is severed with a red-hot knife, so that the severed tissues are thoroughly seared. A sterile hook is used to loosen attachments from below and above, an ordinary abdominal incision having been made with a hot knife. The entire gastro-intestinal tract, with the liver, spleen and pancreas attached, is removed by drawing the string through the bird.

The bird thus drawn is placed in the cold room at 20° F. for twenty-four hours. It is then exposed with the birds of Series B for two days to ordinary temperature (68° C.).

Series B. (*Exposure Two Days, May 2–4, 1907, 68° F.*)

Three birds, No. 1 properly drawn (as described above), No. 2 ordinarily drawn, No. 3 undrawn.

No. 1. Very slight opalescence; no obliteration of marks.

No. 2. Pronounced opalescence; of a solution of 780 c.c. it required 515 to obliterate the marks.

No. 3. Very slight opalescence; no obliteration of marks, but liquid not quite as transparent as in No. 1.

No. 4. Bird from Series A. Pronounced opalescence; of a solution of 780 c.c. it required 680 to obliterate the marks.

Opalescence of No. 2, 1.3 × that of No. 4.

Series C. (*Exposure Three Days, May 4–7, 1907, 68° F.*)

Three birds, No. 1 properly drawn, No. 2 ordinarily drawn, No. 3 undrawn.

No. 1. Slight opalescence; no obliteration of marks.

No. 2. Opacity with yellowish tinge.

No. 3. Opacity with bluish tinge.

Opacity of No. 2 is 1.6 × that of No. 3.

The birds of these three series were very nearly of equal weight.

Series D. (*Exposure Four Days, May 28 to June 1, 1907, 68° F.*)

Three birds, No. 1 properly drawn, = 284.03 g. meat; No. 2 ordinarily drawn, = 205.45 g. meat; No. 3 undrawn, = 349.6 g. meat.

No. 1. Pronounced opalescence, but fluid still very transparent; of a solution of 780 c.c. it required 400 c.c. to obliterate the marks.

No. 2. Opacity with yellowish tinge; of a solution of 780 c.c., 140 c.c. were required to obliterate the marks.

No. 3. Very pronounced opacity; of a solution of 780 c.c., 60 c.c. were required to obliterate the marks.

The ratio of opacity in point of density is the following (calling opalescence of No. 1, opacity 1) : No. 1 = 1.00; No. 2 = 2.85; No. 3 = 6.66.

If, however, correction is made for the much greater weight of meat from bird No. 3, we have the following: No. 1 = 1.23; No. 2 = 4.85; No. 3 = 6.66.

Series E. (*Exposure Five Days, May 29 to June 3, 1907, 68° F.*)

Three birds, No. 1 properly drawn, = 235 g. meat; No. 2 ordinarily drawn, = 222 g. meat; No. 3 undrawn, = 184 g. meat.

No. 1. Pronounced opalescence, but less than that of No. 1, Series D. Solution still very transparent; of a solution of 780 c.c., 500 c.c. were required to obliterate the marks.

No. 2. Dense opacity, but not any more pronounced than that of No. 2, Series D; of a solution of 780 c.c., 120 c.c. were required to obliterate the marks.

No. 3. Dense opacity, somewhat deeper than that of No. 2, this series; of a solution of 780 c.c., 85 c.c. were required to obliterate the marks.

The ratio of opacity, No. 1 bird being taken as a standard, is the following: No. 1 = 1.00; No. 2 = 3.57; No. 3 = 5.88.

Correcting for the difference in weight of meat from the three birds, we have the following: No. 1 = 1.00; No. 2 = 3.74; No. 3 = 7.07.

Series F. (*Exposure Six Days, May 30 to June 5, 1907, 68° F.*)

Three birds, No. 1 properly drawn, No. 2 ordinarily drawn, No. 3 undrawn.

No. 1 bird is simply drying up, without noticeable signs of decomposition. Bird allowed to hang.

No. 2 bird is also drying up. Peritoneal cavity filled with moulds. The presence of these would probably retard the development of aërobic bacteria.

No. 3, the undrawn bird, is in a heavily decomposed condition; it emits a foul odor.

These birds were not examined as to decomposition products, since the facts were sufficiently evident as described above.

From the foregoing results it would appear that at first the undrawn bird does very well, since for twenty-four hours it holds its own with the properly drawn fowl. After this time, however, the undrawn bird begins to break down rapidly. The ordinarily drawn bird holds its own very well, but is not to be compared in its keeping qualities with the properly drawn bird, which in the case of the latter are almost perfect. Undoubtedly the opalescence yielded by the extraction products in the case of the properly drawn bird is due entirely, or nearly so, to autolytic changes in the tissues. The differences in the behavior of cold-storage and freshly killed fowl on exposure to a temperature of 68° F. are easily explained by the bacteriological investigation. It seems that the intestinal tract of the undrawn cold-storage fowl contains practically no aërobic bacteria, the presence of which is of material aid in starting anaërobic growth and decomposition. On this account the anaërobic intestinal bacteria present in the intestinal tract of the undrawn cold-storage bird are very slow to multiply and to invade the peritoneum and muscle tissues.

For all practical purposes, it would seem that the safest method of preparing fowl for cold storage is to draw them without any spilling of the intestinal contents. After removal from cold storage, fowl should never be thawed by soaking in water, because such a procedure is sure to contaminate badly the birds. Thawing should be brought about by allowing the bird to hang in the air for twenty-four hours. If the public would learn to buy the frozen, properly drawn bird, and would then thaw the bird at home, the most satisfactory solution of the problem would be reached.

Summary.

As a result of the foregoing investigation, the following facts may be noted: —

1. In cold storage itself no chemical changes occur. This is shown by: —

(*a*) The absence, after nine months and more of cold storage, in both drawn and undrawn cold-storage fowl of ptomaines and decomposition products in general, except such as are formed by bacteria and autolytic changes occurring before the birds are placed in cold storage and after they are thawed.

(*b*) The negative results of animal inoculations with extracts obtained from the two kinds of poultry.

2. When fowl are taken out of cold storage and exposed to a temperature of 68° F., the conditions of exposure being the same, the undrawn birds show better keeping qualities.

3. When freshly killed fowl are exposed at 68° F. under conditions constant for all the birds exposed, the birds drawn according to the method

described above show perfect keeping qualities, while the undrawn fowl undergo a rapid process of decomposition. Under these conditions the ordinarily drawn birds show fair keeping qualities, although they are not free from bacterial decomposition.

It may be concluded, therefore, from these results that it is best to draw fowl in a different manner from that usually followed, before they are placed in cold storage. After removal from cold storage, the fowl should never be contaminated by soaking in water, but should thaw in the air. Ordinary drawing is worse by far than no drawing at all.

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REPORT

UPON THE

BACTERIOLOGICAL EXAMINATION

OF

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By HERBERT R. BROWN, B.S.

REPORT UPON THE BACTERIOLOGICAL EXAMINATION OF DRAWN AND UNDRAWN POULTRY KEPT IN COLD STORAGE.

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The principal material provided for this investigation consisted of two lots of chickens and one of domestic ducks, which were killed and plucked on the same day in August, 1906, half of each lot drawn and half left undrawn, and forwarded with all possible despatch to the Quincy cold-storage warehouse in Boston, where they were placed in a room the temperature of which was — 14° F. The time which elapsed between slaughter and placing in storage was less than twenty-four hours. Each bird was separately enclosed in practically impervious paper before shipment, and this envelope was not removed until the specimens as needed were withdrawn some months later for examination. The bacteriological examination was begun in each case with as little delay as possible, and hence whatever evidence of bacterial multiplication was found may be attributed to changes which occurred prior to or during storage.

The birds were killed by severing the blood vessels of the throat and piercing the brain by an upward thrust of the knife through the roof of the mouth. They were thoroughly bled by the usual method of suspending them head downward until the greater part of the blood escaped. The severing of the blood vessels of the throat may perhaps offer a possible portal of entrance to such micro-organisms as may be present in the throat at the time of killing, or as may gain access to that area subsequently; but, inasmuch as the rush of blood from the severed vessels causes a more or less complete washing out of the throat, the possibility of such invasion may properly be dismissed as a negligible factor. Moreover, coagulation of any remaining blood in the vessels soon presents an obstacle to such invasion. As will be noted, however, in the following account, the primary lines of decomposition appear to be along the course of the blood vessels. This may be due to infection as a result of the method of slaughter, or, more probably, to penetration of the vessels by bacteria from the tissues through which the vessels ramify.

In addition to the above material were provided one lot of live birds which were killed as needed and various specimens bought in the open market.

LOT I. — Chickens. Previous to Slaughter, fed on Mash.

Series A. — Undrawn.
Series B. — Drawn.

Series A. — Undrawn.

The chickens of Lot I. differed from those of Lot II. in two particulars, namely, in the extent of the drawing and in the feeding prior to slaughter. In Lot I. the "partial" method was followed, and in Lot II. the "complete." Those of Lot I. were fed on "mash," and those of Lot II. on hard grain.

Prior to the bacteriological examination of each bird of either lot a careful examination of the exterior was made, to note the possible existence of portals of entry through which bacteria might have gained access to the tissues. Bruises and scraping or tearing of the skin here and there were noted as extremely common, but the tissues selected for examination were invariably free from such solutions of continuity. Most of the chickens had a superabundance of adipose tissue lining the skin and surrounding the internal organs. Heavy deposits of fat were more than occasionally found in the liver and frequently at the apex of the heart. In one bird the muscular tissue of the right and left ventricles had undergone heavy, fatty infiltration, but to all appearances no ill effects had been produced as a direct result of this accumulation. Another was affected with scabies of the feet, — a disease that is more or less common among chickens; but this would probably have no direct influence on the question at hand.

The influence of exposure to the temperature of the air, which was very warm at the time of slaughter, was shown by the post-mortem changes in some of the livers, which assumed a brownish-yellow color and were flabby, in contrast with the normal organs, which are rich dark brown-red in color and of firm consistence. Microscopic examination revealed nothing beyond deposits of fat, which may have marked the beginning of degeneration and caused more rapid post-mortem changes.

In two birds there was noted a cystic degeneration of the ovarian follicles or ovisacs. The sacs affected were slightly distended, due to the caseation and decomposition of the enclosed yolks, and the walls gave an abnormal appearance of a drab color, but no signs of inflammation. In other respects the two chickens were normal.

One chicken had an enlarged heart, due to pericarditis, possibly brought on by an attack of chicken cholera. There was a more or less organized fibrous growth of the pericardium to the ventricles in various places, but not completely adherent to all the surfaces of the heart. The pericardial fluid and the heart blood gave no evidence of the presence of any causal bacterial agent. The fresh tissue, pericardial fluid and the heart blood were examined microscopically immediately on removal from the carcass, and likewise after incubation at 36° to 37° C. for forty-eight hours in artificial culture media, without result. Accompanying the diseased condition of the heart were found on examination of the gizzard muscle small semilunar bodies, measuring approximately 6 to 7 microns by 3 microns, that were readily stained with methylene blue. No nuclei were seen in either the fresh or the stained preparation, but these bodies may possibly be found with the application of the proper stains to sections of the gizzard tissue.

The microscopic examination of the fresh muscular tissue of all the chickens revealed nothing abnormal. The striations were of uniform width, and no degeneration of the fibers or sarcolemma could be detected. It has been the custom of poultrymen to take frozen chickens and place them in cold water over night for the purpose of removing the ice crystals from the tissues. This caused an absorption of 9 pounds of water per 100 pounds of chickens, or 9 per cent. by weight. By soaking a chicken over night in cold water it was found that the light bands of the muscle fibers assumed a swollen appearance, being much broader than normal.

In five of the undrawn chickens were found completely or partially calcified biconcave disks that contained what were formerly parasitic arachnoidea, embedded in the connective tissue between the muscles and the skin that serves to make up the subcutaneous air sacs. In the calcified condition, the parasite is morphologically unrecognizable, owing to the generally complete granulation resulting from the deposition of inorganic salts; but in one chicken were found morphologically complete larvæ distributed along the course of the lymph channels of the abdominal mesenteries. The bodies and legs of these larvæ were devoid of all hairs and spinous processes, and all of the eight appendages bore at their distal ends sucking disks in place of the recurved hooks commonly found, which serve as organs of prehension. The mouth was not guarded by mandibles, but was modified to carry on a sucking function. The adult form of the larvæ may correspond to the *Dermanyssus gallinæ* (de Geer, 1778), which is synonymous with *Pulex gallinæ* (Redi, 1674), *Acarus gallinæ* (de Geer, 1778) and *Dermanyssus avium* (Dages, 1834). This species is a true ectoparasite, and bears numbers of hairs on the body and the appendages.

Determination of Bacteria.

In determining the numbers of bacteria, samples of tissue of approximately one gram weight were taken from the various muscles of different parts of the body and minced as finely as possible with small scissors, after which the parts were dropped directly into melted agar-agar kept at a temperature of 40° C. After thoroughly washing the tissue with the agar, the inoculated culture media was poured into sterile Petri dishes, cooled to solidify the agar, and then subjected to incubation at 36° to 37° C. for forty-eight hours.

The samples examined were selected with the utmost care, under sterile conditions, and well away from bruises and tearings of the skin. The muscles examined were the right and left pectoralis, subclavius, coraco-branchialis longus; the thigh muscles, both at their dorsal origin and at a point located about the middle of the femur; the leg muscles, the peroneus medius generally being selected; the extensor coccygis, the uropygium muscles; the external and internal oblique abdominal muscles; and the heart muscles. The remaining parts examined consisted of parts of the crop cavity, the epithelial tissue of that organ, the deep tissues of the gizzard muscle, the deep liver tissue, deep spleen pulp, the superficial and deep kidney tissue, the heart blood, swabs of the peritoneum next to the coils of the intestines, swabs of the ventral air sac, and swabs of the pleural sacs themselves.

The pectoral muscles contained but few bacteria, the numbers varying from none at all to 500 per gram of muscle tissue. The organisms isolated proved to be staphylococcus types and a short facultative anaërobic bacillus. Neither of the varieties found was able to resist heating to 80° C. for twenty minutes. The subclavian muscles were found to be even less infected than were the pectorals, the numbers ranging from 0 to 150 per gram weight. Infection of these muscles must take place from the blood, as a vehicle of transmission, by bacteria from the thoracic cavity or from the pectoralis muscle which covers it completely. A micrococcus, a diplococcus and a short bacillus were the only types of bacteria found when grown on artificial culture media at 36° to 37° C. The coraco-branchialis longus, which lies even nearer to the thoracic cavity, contained but 1 to 4 bacteria per gram weight. The only variety found was a staphylococcus.

The thigh muscles at their origins contained smaller numbers of bacteria than they did at approximately the middle of the femur, the numbers ranging from 4 to 32 in the former and from 50 to 400 in the latter. The numbers of bacteria in the muscles near the middle of the femur may have been raised by direct infection through the abdominal muscles from the peritoneal cavity, which may possibly have taken place previous to storage. There is also a possibility that the blood was infected, and that the bacteria migrating through the walls of the femoral vessels raised the bacterial content of the muscles. This is thought to be improbable, however, for the bacterial content of the heart blood was found to be low, and such being the case, the chances are that the blood in vessels of the extremities likewise contained but few bacteria. The muscles were of normal color and consistence. The leg muscles contained but a small range of bacteria, or 1 to 150 per gram weight. If the blood was the cause of the rise in numbers of bacteria in the part of the thigh muscle just mentioned, then we would anticipate a corresponding rise in the muscles of the leg; but, as has just been shown, this was not the case, and accordingly the explanation of the infection coming from the abdominal cavity may be accepted as more plausible. The inner sides of the thigh muscles are in close approximation to the abdominal muscles, so that bacteria can easily pass through the intervening connective tissue, and cause the infection shown above.

The abdominal muscles selected were the internal and external oblique muscles of the right side, those being in closest relation to the coils of the intestine, and naturally they would be infected to the heaviest extent. Care was always taken in excising the muscles to leave the peritoneum intact, thus preventing bacteria that might be present on the serous surfaces from influencing the figures representing the bacterial content of the abdominal muscles. The numbers of bacteria found ranged from 72 to 1,200 per gram weight. The species found were *staphylococcus albus, staphylococcus citreus, bacillus butyricus* and several unidentified bacilli.

The muscles of the uropygium contained much larger numbers of bacteria than the foregoing, the cause of which is that a portal of entry is offered by the aperture of the teat of the oil gland on the dorsal side of the appendage. Cutting into the uropygium always opened the oil gland, and the general lubrication that followed resulted in raising the numbers of bacteria per gram considerably, there being a range from 6,594 to 15,959 per gram of muscle tissue. There was a general mixture of varieties of bacteria found in the uropygium: *staphylococcus albus, staphylococcus aureus, staphylococcus citreus, bacillus butyricus* or like, streptococci, streptothrix, *bacillus subtilis,* etc. The caudal vertebral muscles never exceeded 32 to 37 bacteria per gram weight.

The crop cavities and the epithelial surfaces of the organs were swabbed with pieces of sterile cotton to pick up such bacteria as might be present, and the pledgets of cotton were then placed in suitable culture media which were kept in the thermostat for the next forty-eight hours. The bacteria found here were the *staphylococcus albus,* the *staphylococcus citreus* and the *staphylococcus aureus,* together with a chromogenic diplococcus; the numbers ranged from 16 to 352, and represent in a general way the extent of infection. Pledgets of cotton of approximately the same size were used, and about the same extent of surface was covered in the swabbing process, so that the results are comparable.

The gizzard was infected with bacteria from the hands during the process of removal of the gut, and accordingly the epithelial cells were thoroughly seared before removing the sample to be tested. This showed perfectly the extent of invasion by bacteria from the peritoneal cavity. The muscles were practically sterile, for in but one instance was growth developed and this proved to be *staphylococcus albus.* The liver and spleen likewise contained very low bacterial contents, the numbers never exceeding 6 to 12 micro-organisms per gram of tissue. The types of bacteria were staphylococci of the albus and citreus groups.

The internal organs of the birds are separated from one another by delicate or tough fibrous membranes, according to location. Each lung is inclosed by an oblique septum that shuts it away from the heart and peritoneal cavity; the heart is inclosed by the pericardium; the liver and gizzard, separated from the intestines by dextro and levulo mesenteries, lie within the ventral air sac; and the intestines, well over to the right side of the body, are practically isolated from the other parts. The numbers of bacteria that had passed through the walls of the intestine were estimated by cutting through the right abdominal muscles with sterile instruments, inserting a sterile pledget of cotton through the opening, and rubbing it thoroughly, but carefully over the walls of the peritoneum and also over the outer walls of the intestines. The numbers of bacteria were low, ranging from 62 to 2,200 in most birds; but in a few instances it was shown that countless germs were present, which indicated a heavy passage of the germs from the intestine, and probably multiplication in the cavity after passage. The numbers of bacteria found in the pleural part of the pleuro-peritoneal cavity, as distinguished from the peritoneal part just discussed, were present in numbers varying from 3 to 1,482. By the exposure of a bird for seventy-two hours at 72° F., the bacteria were raised to 23,458 in the pleural part of the cavity and to 41,050 in the peritoneal part.

In conjunction with the determination of the numbers of bacteria in the muscles and corresponding cavities, pieces of tissue and pledgets of cotton from the different parts were inoculated into tubes containing ordinary bouillon plus 1 per cent. dextrose. In the addition of the muscle tissue to the broth the piece was not minced as in the case of the tissue added to the agar, but was inserted directly into the tube. By the study of the gas production, the microscopic examination of the deposits in the fermentation tubes and the isolation of the various species by the agar plate method or by roll cultures of gelatin, it was possible to determine by inference the sources from which the micro-organisms came. In all but one of the pectoral muscles examined the tissues were sterile when immersed in the broth and incubated. One test showed the presence of a bacillus acting on dextrose that had in all probability gained entrance through some abrasion of the skin, the bird from which the sample had been taken having many such abrasions. The test of the pectoralis of a chicken that had been exposed to 70° F. for seventy-two hours showed no infection whatsoever. The subclavius muscles were found to be sterile in all cases, except that of a bird exposed three days. The same was true of the muscles lying over the coracoids, the thigh muscles at their origins, the muscles over the synsacrum just anterior to the uropygium, the swabbings of the crop cavities, the abdominal muscles, the gizzard and the spleen. Samples of tissue taken from the uropygium generally contained bacteria, supposedly from the alimentary tract; it is probable that the bacteria were present before death, the gland having been infected by the bill. The thigh muscle at the middle of the femur was found to be sterile in all cases, except when the animal was exposed to 72° F. for three days, when the development of transitional colon bacilli that undoubtedly came from the intestine through the abdominal muscles was brought about. The same result was found in the leg muscles, exposure being necessary in order that zymogenic bacteria might be found. It seems likely that the blood vessels offered paths of least resistance to the migratory forms, which accordingly worked their way to the extremities. In the test of the peritoneal parts of the pleuro-peritoneal cavity three chickens were found to be uninfected; a fourth showed the presence of no bacteria after heating the sample to 80° C. for twenty minutes, which proves the absence of spores of anaërobic bacteria. The remainder of the birds tested showed that *bacillus coli*, or like organisms, had passed from the intestines to the peritoneal cavity, and were often mixed with bacilli resembling the *bacillus cloacæ*, forms of which were isolated and stored for later identification. The thoracic part of the cavity with two exceptions contained *bacillus coli* or like organisms, whose presence in this part of the carcass may possibly be attributed to a passage through the walls of the gullet after a retromigratory course along the alimentary tract, or to the gradual general seeding of the entire cavity. At the time of placing in cold storage, the migratory types of bacteria were ready to begin the invasion of the tissues with suitable exposure to the proper temperature. The bacterial content of the chicken intestine changes with each change of food, and, while *bacillus coli* may always be found, the numbers of the bacillus are not constant.

In chickens exposed for three days spore-bearing anaërobes were developed from samples taken from the wall of the peritoneum of the right side of the body.

In the bacteriological tests of the peritoneal part of the pleuro-peritoneal cavity of the chickens of this series 66.67 per cent. were found to contain bacteria of intestinal origin, 22.22 per cent. merely coccus infections whose source is unknown, and 11.11 per cent. of the birds possessed sterile cavities.

The pleural part of the cavity of the chickens when tested showed that 71.4 per cent. of the birds were infected with zymogenic bacteria (not anaërobes), 14.3 per cent. showed only a micrococcus infection and 14.3 per cent. possessed sterile cavities.

Series B. — Drawn.

Most of the chickens of this series had skin abrasions at such prominent parts of the body as the elbows of the wing and the hips, some of them being sufficiently gross to ensure entrance of bacteria to the exposed muscles. In a few of the birds the crop had been left intact, through error of the workmen; but in the remainder it was removed through an incision about 4 to 6 inches long on the dextro-lateral part of the neck. Viewed from the ventral side, there was no indication that the crop had been taken out, and, while it must be admitted that the appearance is better, the opportunity for such complete aëration as would be the case if the incision were made on the ventral side is not afforded. Viewing the bird from the right side, it was noted that the operation had been hurriedly performed, resulting in a profuse scattering of the contents of the crop and part of the gullet over the adjacent tissues. The trachea was generally found in its normal position, though occasionally it was absent, having been removed in the process of drawing. Beyond the cutting of the large blood vessels at the base of the heart, no attempt was made to remove the contents of the thoracic cavity.

The drawing process as performed on this lot of birds consisted in severing the duodenum close to the gizzard, and removing the entire intestine, part or all of the oviduct and the cloaca. It is reported that after the removal of the intestines the birds were thoroughly wiped out with a moist cloth; this method naturally caused a profuse seeding of the entire peritoneal part of the pleuro-peritoneal cavity with intestinal bacteria set free from the duodenum and possibly from feces squeezed out of the cloaca. The organs or parts thereof that were not removed were the upper part of the gullet from the crop to the throat, the lower part of the same from the crop to the proventriculus, the proventriculus, the gizzard, the ovaries, part or all of the oviduct, the heart, lungs, liver, spleen and kidneys.

Two chickens of this lot were infected with the same parasitic arachnoidea as was mentioned above. In other respects all the birds were normal. The red corpuscles, as in the previous lot of chickens, were completely destroyed by the freezing temperature (— 14° F.) of the warehouse. Microscopic examination of the muscle fibers yielded results similar to those observed on examination of the undrawn birds.

Determination of Bacteria.

In order that the results might be strictly comparable with those obtained in the examination of the undrawn birds, samples were selected from the corresponding muscles and parts, and the methods employed throughout were identical.

The pectoral muscles contained small numbers of bacteria, ranging from 0 to 250 per gram weight. The species found were chiefly staphylococci, a few streptococci and a short bacillus measuring approximately 1.5 micron by 0.7 micron when grown on agar.

The subclavius muscles contained smaller numbers of bacteria than the pectorals, the range being from 0 to 100 per gram weight. *Bacillus subtilis,* micrococci, diplococci and a type of streptothrix were the microorganisms found. The coraco-branchialis longus contained streptococci, *staphylococcus albus,* streptothrix, *bacillus prodigiosus* and a short bacillus resembling *bacillus coli* morphologically, but not on culture media. The numbers ranged from 1 to 7 bacteria per gram weight.

The thigh muscles at their origins contained from 1 to 14 bacteria per gram of tissue, while at or near the middle of the femur there were 150 to 200 per gram. After three days' exposure to room temperature (72° F.), the number of bacteria at the latter point was found to be 610 per gram of tissue. Micrococci, streptococci, a spirillum, *bacillus coli* or like and *bacillus ramosus* were isolated. It may be assumed, as was pointed out above, that the high infection of the muscles at the middle of the thigh is caused by reason of their relatively intimate contact with the abdominal muscles, which act as a very ineffective, thin barrier between the intestines and the thigh in the undrawn chickens, and between the peritoneum heavily seeded with bacteria and the thigh in the drawn chickens. The leg muscles contained from 0 to 150 bacteria per gram weight; on exposure, this number was raised but slightly, only 164 bacteria per gram of tissue being found. Staphylococci and *bacillus coli,* or like organisms, were the only types found.

The abdominal muscles were always heavily infected, a condition to be anticipated, considering that there was a copious seeding of the abdominal cavities with bacteria during the process of drawing. By heating to 80° C. for twenty minutes, the bacteria present were found to be either non-spore-bearing types or bacteria of non-resistant species, for all were easily destroyed at this temperature. The numbers ranged from 1,344 to 19,900 per gram. Staphylococci were always present, associated with greater or lesser numbers of aërobic bacteria. No anaërobes were found, for the environment was not favorable to their development, although they may have been, and probably were, present in latent condition.

The uropygium contained from 7,068 to countless numbers of bacteria per gram weight of tissue. The usual aërobic bacteria were present, but the predominating types were anaërobic bacilli, accompanied in certain instances by colon or like bacilli. The cause of the vast difference in the numbers of bacteria in the uropygium of the drawn as compared with the undrawn chickens is obscure. The explanation may be found in the treatment of the undrawn birds, which, it is remembered, were wiped out after removal of the viscera; the cloth must have become rich in intestinal bacteria, and the water used to moisten the cloth may have become heavily infected, some of the bacteria gaining entrance to the oil gland of the appendage, thus raising the bacterial count.

The caudal vertebral muscles contained from 140 to 3,000 bacteria per gram weight. Transitional colon bacilli were found, together with forms of streptothrix and staphylococci.

When the crop was left intact, tests of the cavity of that organ gave about the same results as those of the undrawn chickens, not over 32 bacteria being swabbed out with the sterile pledgets of cotton. In those whose crops had been removed, the numbers of bacteria were invariably noted as countless. *Staphylococcus albus, staphylococcus citreus, staphylococcus aureus* and allied staphylococci, streptococci, spirilli, *bacillus megaterium, bacillus coli* and transitional forms of the same and some anaërobic bacteria were found. In the examination of many birds the gizzard was found to be missing, but when present the bacteria were never found to exceed 1 per gram of tissue. Only the deep muscle tissue lying below the epithelium was tested, for the surface of the organ was always heavily coated with bacteria. Micrococci and one anaërobe were isolated.

The spleen was more highly infected than the liver, the numbers of bacteria in the former running as high as 47 per gram, while in the latter organ there were never more than 2 per gram. Micrococci and a short bacillus were found in the liver tissue, while micrococci only were present in the spleen.

The peritoneal part of the pleuro-peritoneal cavity invariably contained countless bacteria, excepting in one instance, when the yield was as low as 12,380.

Exposure of the chickens for three days to room temperature caused a rapid multiplication of the already countless bacteria, and the meat was thereby made unfit for consumption. The bacteria were almost all non-resistant, for exposure to 80° C. for twenty minutes reduced the countless bacteria to 11 and less. Streptothrix, streptococci and staphylococci were found, but the predominating types were intestinal bacteria, such as *bacillus coli* and anaërobes. The pleural sacs were examined after severing the oblique septa and swabbing out the cavities with sterile pledgets of cotton. The numbers of bacteria were considerably smaller than those found in the peritoneal part, the range being from 127 to 1,729 picked up on the pledget. Some of the bacteria were heat-resisting, but no spore-bearing anaërobes were found. Typical colon bacilli, together with transitional forms of the same, were almost invariably found, showing that there had been a migration of these bacteria to this region. Occasionally the heart blood was sterile, but as a rule aërobic bacteria, such as *bacillus subtilis* and non-zymogenic types, were found.

Fermentation tests were made as with Series A by inoculating tissue or pledgets of cotton after swabbing the epithelial surfaces in the different cavities into peptonized beef broth, to which 1 per cent. of dextrose had been added. The samples of tissue taken from the pectoralis never contained bacteria capable of splitting dextrose. The same was true of the samples taken from the subclavius, coraco-branchialis longus, the dorsal origin of the thigh muscles, the middle of the thigh (except when the bird was exposed to room temperature for varying periods), the gizzard and the spleen. The caudal vertebral muscles were found to contain typical colon bacilli, while the uropygium was usually infected with transitional types of this bacillus. The leg muscles were sometimes sterile, and sometimes they contained anaërobic bacilli. The abdominal muscles were infected with anaërobes and other intestinal bacteria. The latter were present in the liver tissue and likewise in the kidneys. As was to be expected, zymogenic bacteria were invariably present in the thoracic and peritoneal cavities of all birds. The predominating species was not always the same, but varied with the individual birds. *Bacillus* *coli* or like species were frequently found; anaërobes, though few in numbers, were generally present; *bacillus cloacæ* were occasionally found; micrococci and fungi were also present, but the former at least was suppressed in the fermentation tubes by other bacteria.

In the examination of the body cavities it was found that 90 per cent. of the bacteria present in the peritoneal part of the cavity were zymogenic types of undoubted intestinal origin; and 10 per cent., while exerting no action on dextrose, may possibly have been derived from the same source. Tests of the bacterial content of the pleural part of the pleuro-peritoneal cavity showed that in 85.7 per cent. the bacteria present were from the intestinal contents; when the pleural septa were not broken, as in 14.3 per cent., the bacterial results were negative.

Summary, Lot I.

Results of the Bacteriological Examination of Drawn and Undrawn Chickens of Lot I.

Muscle or Part selected.	Undrawn Chickens. — Numbers of Bacteria per Gram of Tissue.	Drawn Chickens. — Numbers of Bacteria per Gram of Tissue.
Pectoralis,	0 to 500,	0 to 250.
Subclavius,	0 to 150,	1 to 100.
Coraco-branchialis longus,	1 to 4,	1 to 7.
Thigh muscle at dorsal origin,	4 to 32,	1 to 14.
Thigh muscle at middle of femur.	50 to 400,	150 to 200 (by exposure to 72°F. 3 days, 610).
Leg (peroneus medius),	1 to 150,	0 to 150 (by exposure, 164).
Abdominal muscles,	72 to 1,200,	1,344 to 19,900.
Uropygium,	6,594 to 15,959,	7,068 to countless numbers.
Caudal vertebral muscles,	32 to 37,	140 to 3,000.
Swab of crop cavity,	16 to 352 (swabbed out),	Crop intact, — 32 bacteria swabbed out. Crop removed, — countless bacteria swabbed out.
Gizzard,	0 to 1,	1.
Liver,	4 to 6,	2.
Spleen,	0 to 12,	47.
Bacteria swabbed out of peritoneal part of pleuro-peritoneal cavity.	62 to 2,200 (by exposure for 3 days at 72° F., 23,458 bacteria swabbed out).	12,380 in 1 chicken; countless in all the remainder.
Bacteria swabbed out of pleural part of pleuro-peritoneal cavity.	3 to 1,482 (41,050 bacteria swabbed out).	127 to 1,729.
Heart blood,	0 to 32,	B. subtilis only.

Comparative Table of the Types of Bacteria found in the Muscles and Cavities.

MUSCLE OR PART SELECTED.	Undrawn Chickens. — Varieties of Bacteria.	Drawn Chickens. — Varieties of Bacteria.
Pectoralis,	Staphylococci and facultative anaërobe.	Staphylococci, streptococci and a short bacillus.
Subclavius,	Coccus, diplococcus and short bacillus.	B. subtilis, micrococci, diplococci and streptothrix.
Coraco-branchialis longus,	Staphylococci,	Streptococci, staphylococci albus, streptothrix, b. prodigiosus and a colon-like bacillus (morphologically).
Thigh muscle at origin (dorsal).	Staphylococci albus, b. subtilis, streptothrix.	Micrococci, streptococci, spirilli, b. coli or like, b. ramosus.
Thigh muscle at middle of femur.	Micrococci, staphylococcus citreus, streptothrix.	Micrococci, staphylococcus citreus, streptothrix.
Leg,	Micrococci, bacilli,	Staphylococci and b. coli or like.
Abdominal muscles,	Staphylococci: citreus, aureus; b. butyricus and other bacilli.	Staphylococci and aërobic bacteria.
Uropygium,	Staphylococci: albus, citreus and aureus; b. butyricus, streptococci, streptothrix, b. subtilis.	Anaërobes, aërobes, micrococci and colon-like bacilli.
Caudal vertebral muscles,	Streptothrix, staphylococci: albus, aureus and citreus.	Transitional colon bacilli, streptothrix and staphylococci.
Swab of crop cavity,	Staphylococci: albus, aureus, citreus; and chromogenic diplococci.	Staphylococci: aureus, albus, citreus, etc.; streptococci, spirilli, b. megaterium, b. coli, and transitional forms and anaërobic bacteria.
Gizzard,	Staphylococcus albus,	Micrococci and one anaërobe.
Liver,	Staphylococci: albus and citreus,	Micrococci and a short bacillus.
Spleen,	Staphylococci: albus and citreus,	Micrococci.
Peritoneal part of pleuro-peritoneal cavity.	Intestinal bacilli, diplococci, b. coli, streptothrix, staphylococci: aureus, citreus, albus; streptococci, b. subtilis.	Streptothrix, streptococci, staphylococci, intestinal bacteria, b. coli or like and anaërobic bacilli.
Pleural part of pleuro-peritoneal cavity.	Micrococci, intestinal bacteria, staphylococci: aureus, citreus.	B. coli or like, anaërobes and micrococci.
Heart blood,	Micrococci and b. subtilis,	B. subtilis.

Of the undrawn birds (Series A), 66.67 per cent. showed infection of the peritoneal part of the pleuro-peritoneal cavity with intestinal bacteria, 22.22 per cent. showed coccus infection of this cavity and 11.11 per cent. possessed sterile cavities. The pleural part when tested showed the presence of intestinal bacteria in 71.4 per cent. of all the birds; 14.3 per cent. showed a micrococcus infection, and in 14.3 per cent. the cavities were sterile.

Of the drawn birds (Series B), 90 per cent. showed intestinal bacterial infection of the peritoneal part of the pleuro-peritoneal cavity, while the remaining 10 per cent. showed infection with bacteria that may or may not have come from the intestine. The pleural cavities of 85.7 per cent. of the birds were infected with bacteria of undoubted intestinal origin, and of 14.3 per cent. they were sterile.

LOT II. — CHICKENS. PREVIOUS TO SLAUGHTER, FED ON HARD GRAIN.
Series C. — Undrawn.
Series D. — Drawn.

SERIES C. — UNDRAWN.

The birds of Lot II. were like those of Lot I. in all respects, but prior to slaughter were given hard grain rather than mash. Generally speaking, their condition was normal, but four of them were infested by subcutaneous arachnoidea, and in one of these the parasites at the time the birds were frozen were working their way along the lymph channels of the abdominal mesenteries. One bird had cystic degeneration of the ovaries, another had a small tumor on the dorso-ventral mesentery, and another had scabies of the feet. Other variations from normal consisted in bruises and tears made during the process of plucking.

On being thawed at room temperature, the birds presented absolutely no sign of decomposition. Microscopic examination of the blood showed that the red corpuscles had been destroyed by freezing, so that the blood vessels and heart contained serum colored with free hemoglobin but no erythrocytes. The muscle fibers from all parts were normal.

Determination of Bacteria.

The bacteria in the pectoral muscles were so few in number as to be practically negligible. They ranged from 0 to 34 per gram of tissue, and included *staphylococcus albus, staphylococcus aureus, bacillus subtilis,* diplococci, and short non-zymogenic bacteria. After exposure to room temperature for several days intestinal forms were found. The pectoralis was sterile after soaking in water and subsequent exposure to 72° F. for twenty-four hours. The subclavius never contained more than 3 nor fewer than 2 bacteria per gram; and after forty-eight hours' exposure to 72° F. only 1 bacterium per gram was found; *bacillus subtilis* and one type of streptothrix were isolated. The coraco-branchialis longus contained from 1 to 6 bacteria per gram of tissue, but these increased in number to 971 per gram by two days' exposure to room temperature. *bacillus subtilis,* streptothrix and two unidentified bacilli were isolated. The thigh muscles at their dorsal origin contained from 0 to 26 bacteria per gram of tissue, while at the middle of the femur the tissues were sterile excepting once, when 3 bacteria were found. On thawing the bird in cold water for twenty-four hours, with subsequent exposure to 72° F. for another like period, the numbers were raised to 183 per gram. The organisms isolated from the tissues at the dorsal origin of the thigh muscles were *staphylococcus albus, staphylococcus citreus* and fungi, while those found at the middle of the femur were *staphylococcus albus* and allied forms of cocci, *bacillus subtilis* and intestinal bacteria. From the bird soaked in water for twenty-four hours, typical colon bacilli were isolated. The leg muscle of one chicken contained 36 bacteria per gram, and that was the only case in which there was more than 1 bacterium per gram. Staphylococci and types of streptothrix were found, but on exposure to room temperature for several days colon and other intestinal bacteria were found; and this was the case also with birds soaked in cold water and exposed to room temperature for twenty-four hours. By this method of treatment, which is usual in the trade, the bacteria per gram were increased in number to 176.

The abdominal muscles contained from 0 to 6 bacteria per gram, — all micrococci. By exposure to 72° F. for forty-eight hours after thawing at room temperature the number per gram increased to 1,550. Transitional colon bacilli were practically the only invading forms, conditions not being favorable to the development of anaërobic bacilli.

The uropygium yielded larger numbers of bacteria, — from 12 to 310 per gram. These included micrococci, *bacillus subtilis,* transitional colon bacilli and other intestinal bacteria. The caudal vertebral muscles contained 4 to 18 bacteria per gram. The epithelial surfaces of the crop and those of the adjacent tissues when swabbed out yielded from 8 to 11 bacteria. *Staphylococcus albus, bacillus subtilis, bacillus ramosus* and *bacillus spinosus* were isolated from these parts. The gizzard, liver and spleen contained not more than 5, 1 and 3 bacteria, respectively, per gram, and *staphylococcus albus* was the only species found. The examination of the cavities consisted as before in swabbing the epithelial tissues with bits of sterile cotton, and determining the number of bacteria picked up, as well as their species. From the peritoneal part of the pleuro-peritoneal cavity from 13 to 1,732 bacteria were picked up by the cotton swab; soaking in water for twenty-four hours and exposure to 72° F. for twenty-four hours raised the number of bacteria to 20,199. After exposure to room temperature for two days, 13,266 bacteria were gathered by the swab in the peritoneal part of the cavity. *Staphylococcus albus, staphylococcus citreus, bacillus subtilis, bacillus coli* and like bacilli and *bacillus cloacæ* were found, and after exposure to room temperature there were found anaërobic bacteria also. In connection with the penetrating and migratory powers of intestinal bacteria, it was shown that, of the birds thawed at room temperature and subjected to no further exposure, 41 per cent. were found to contain no intestinal bacteria in the peritoneal part of the pleuro-peritoneal cavity, and of the remaining birds only 25 per cent. contained zymogenic bacteria of probable intestinal origin. The pleural part of the pleuro-peritoneal cavity contained much fewer bacteria, the numbers picked up by the pledget of cotton ranging from 1 to 423. After soaking in water for twenty-four hours and exposure to 72° F. for a like period the number of bacteria found was 1,705. The organisms were largely intestinal bacteria, whose migration from the intestine had been facilitated and accelerated by the immersion. *Staphylococcus albus, staphylococcus citreus, staphylococcus aureus* and allied forms, streptococci, *bacillus subtilis,* streptothrix, moulds, *bacillus coli,* transitional forms of *bacillus coli, bacillus cloacæ, bacillus megaterium, bacillus butyricus* and other bacilli were identified. No intestinal bacteria were found in the pleural part of the cavity in 30.9 per cent. of the birds, and no zymogenic types were found in 38.4 per cent.; but 30.7 per cent. contained very active intestinal bacilli.

After complete thawing, one chicken was exposed five days to room temperature (72° F.), and then examined. The gullet region of the neck was found to be discolored, the prevailing color being a brownish-red; the crop, seen through the skin over the organ, was pale green in color and slightly dilated, owing to gas production within its walls; the right and left sides immediately posterior to the ribs showed a slight greenish discoloration and gas beneath the skin; the abdomen was much distended by gas in the intestines; and the cloaca had become sealed by the drying of the mucus, and was surrounded by a green area deeper in color than that of the crop. The pectoral, thigh and leg muscles were still firm, and, although giving off foul odors, were but slightly below the normal in appearance.

The pectoralis muscle contained countless bacteria per gram, mostly intestinal forms, consisting of facultative non-spore-bearing aërobic bacilli as predominating types, mixed with obligatory and facultative anaërobes in non-spore-bearing condition. The thigh contained 19,845 bacteria per gram, chiefly spore-bearing and non-spore-bearing anaërobes, with small numbers of facultative aërobes of intestinal origin. The leg muscles contained 9,866 bacteria per gram, chiefly facultative aërobic bacilli of intestinal origin. The peritoneal and pleural parts of the pleuro-peritoneal cavities contained countless facultative anaërobes.

Fermentation tests of samples corresponding to those collected for the purpose of determining the bacterial content were made from each bird.

The pectoralis contained no zymogenic bacteria, but after the bird was soaked in water for twenty-four hours transitional colon bacilli were found; and after exposure, facultative aërobes and anaërobes capable of splitting dextrose were isolated. The subclavian muscles were found to yield no zymogenic bacteria. The coraco-branchialis longus, the thigh muscles at their dorsal origin and at the middle of the femur, the abdominal muscles, the swab of the crop cavity, the gizzard, liver and spleen in the unsoaked and unexposed birds showed no infection with intestinal zymogenic bacteria; while tests made of the coracoid muscles, thigh, leg and abdominal muscles from water-soaked and exposed chickens showed heavy invasion by intestinal bacteria of the aërobic and anaërobic types. Concerning the general nature of the bacterial infection, it was shown that of all the chickens tested 40 per cent. gave evidence that bacteria had passed through the intestinal wall to the peritoneal part of the pleuro-peritoneal cavity, 33⅓ per cent. showed infection by aërobes not of the fermentative class, and in 26.6 per cent. the peritoneal cavity was sterile. The pleural part of the pleuro-peritoneal cavity showed coccus infection in 18.19 per cent., zymogenic bacteria of probable intestinal origin in 54.54 per cent. and sterility in 27.27 per cent.

The results of the *exposure experiments* may be summarized as follows: —

Exposure, Two Days. — General evidence of decomposition along the course of the gullet, at the crop, at the cloaca, all having assumed a pale to moderately deep green color, and along the course of the peripheral veins, the most prominent of which were those of the wings, the jugulars and the subclavians. The liver was slightly below normal in appearance; there was fermentation with gas production in the auricles of the heart and also in the pericardial fluid; the intestines were collapsed and the contents were fluid. The subclavius contained but 1 bacterium per gram, the coracoid muscles 971 and the abdominal muscles 1,550 per gram; the heart blood yielded 12,852 bacteria per loop (loop = 3 m.m. diameter), and the peritoneal part of the pleuro-peritoneal cavity yielded 13,266 to the pledget of cotton passed over the epithelial surfaces. The pectoralis, coracoid and abdominal muscles contained many intestinal bacteria, and the same was true of the pleuro-peritoneal cavity, but tests for anaërobic bacteria were negative.

Exposure, Five Days. — At the end of five days the colors mentioned above had become deeper in shade throughout, and in addition there was gaseous fermentation in the crop, in the intestines and beneath the skin. Offensive odors of decomposition were given off from the carcass and from the excised deeper muscles and the superficial muscles, although both were but slightly below normal in appearance. The pectoralis contained countless intestinal bacilli per gram, the micrococci having been suppressed; the thigh contained 19,845 and the leg 9,866 per gram. In the pleuro-peritoneal cavity bacteria swarmed in countless numbers. All parts contained intestinal bacteria, but the thigh and peritoneal part of the pleuro-peritoneal cavity were the only places where typical resistant spore-bearing anaërobes were found. Decomposition at this time was being carried on almost entirely by facultative aërobic bacilli, the anaërobes not being in the proper environment for development to any appreciable extent.

Thawing in Water for Twenty-four Hours and Subsequent Exposure to 72° F. for Twenty-four Hours. — The soaking process facilitated bacterial development, and the bird exposed for twenty-four hours to 72° F., after twenty-four hours immersion in water, was found to be in a more advanced stage of decomposition than the one exposed for forty-eight hours, described above. The pectoralis contained diplococci only; the leg muscle contained 176 bacteria per gram, consisting of staphylococci and transitional colon bacilli; the thigh at the middle of the femur yielded 183 bacteria per gram, including *staphylococcus albus* and related micrococci, together with colon bacilli or like; the peritoneal part of the pleuro-peritoneal cavity gave 20,199 bacteria to the pledget of cotton, and the pleural part gave 1,705, in each case the types represented being aërobic and probable anaërobic bacilli, together with micrococci, most of which were undoubtedly of intestinal origin. During the period of soaking there was an absorption of about 9 per cent. of water by weight.

SERIES D. — DRAWN.

The chickens of this lot were not drawn in the same manner as those of Lot I., for in the majority of the birds all the organs except the kidneys, lungs and heart had been removed. In 25 per cent. of the birds the crops and gullets were intact. By this method of drawing, anaërobic conditions were rendered most unfavorable, and, if the operations had been carried out in a more careful manner, so as not to spill the contents of the intestines over the tissues, the birds might have been able to withstand exposure for considerable time; but, as is shown below, the cavities were even more extensively seeded with bacteria than those of the corresponding series of Lot. I. The coracoid arch was invariably plugged air-tight by the trachea, gullet and large blood vessels, together with their attachments; but a similar condition did not exist at the posterior end, for there was a large piece of skin and abdominal muscle removed from the ventral side of the carcass, in company with the cloaca, thus leaving a hole of approximately two to three inches in diameter, which offered abundant opportunity for the entrance of oxygen to the cavity, thus interfering with anaërobic growth.

Leaving the lungs, kidneys, crop, gullet and small pieces of liver in the cavity was objectionable, because their presence favored the development of such aërobes as carry on the primary processes of decomposition of flesh.

With the exception of scabies of the feet in two instances, and the usual abrasions of the skin, all the birds were normal.

Determination of Bacteria.

The pectoralis contained from 0 to 6 bacteria per gram: *bacillus subtilis, staphylococcus albus* and related types, and other bacilli of a non-fermentative nature. The subclavius was invaded to a slightly higher degree, the numbers ranging from 0 to 20 per gram: *staphylococcus albus* and allied species, streptothrix, *bacillus subtilis* and transitional colon bacilli or like were the species found. The coraco-branchialis longus yielded 2 to 1,049 bacteria per gram; *staphylococcus albus, staphylococcus citreus,* streptothrix and *bacillus coli* were isolated. The thigh muscles at their dorsal origins were more highly infected with bacteria than the parts at the middle of the femur, the numbers ranging from 13 to 1,311, and from 2 to 340, respectively, per gram. At their origin the thigh muscles yielded *staphylococcus albus* and allied forms, *bacillus subtilis* and *bacillus lactis aërogenes* as determined by morphological and biochemical tests; from the muscle at the middle of the femur *bacillus subtilis, staphylococcus albus* and a transitional colon bacillus were isolated.

The leg muscles yielded from 0 to 57 bacteria per gram; streptothrix, *staphylococcus albus,* streptococci, *bacillus subtilis* and other aërobic bacilli. The abdominal muscles were but slightly infected with bacteria, the numbers ranging from 6 to 99 per gram; *staphylococcus albus, bacillus coli* and non-spore-bearing bacilli of a possible anaërobic character were found. The uropygium was found to contain the usual large number of bacteria when no care was exercised to avoid the oil gland or tubules, but when only the tissues well away from the gland were selected, the numbers of bacteria ranged from 4 to 6 bacteria per gram. *Bacillus subtilis, staphylococcus albus, staphylococcus citreus,* etc., were the types isolated. The caudal vertebral muscles contained but 0 to 7 bacteria per gram, and *bacillus subtilis* was the prevailing species found.

When the crop was intact, the pledget of cotton swabbed over the epithelial surfaces picked up from 2 to 30 bacteria. Streptococci, *staphylococcus albus,* streptothrix and unidentified bacilli, but no obligatory or facultative anaërobes, were present. The gizzard, liver and spleen had been removed from each bird in the process of drawing, so the tests of these tissues were necessarily omitted. The heart blood contained as high as 48 bacteria per loop (loop = 3 m.m. diameter). These included *staphylococcus albus, bacillus subtilis,* streptococci, and short and long unidentified bacilli. As was anticipated, the peritoneal part of the pleuro-peritoneal cavity was heavily seeded with bacteria, which, with one exception (20,199 bacteria on the cotton pledget), were present in countless numbers. Streptococci, *staphylococcus albus* and related groups, sarcine types, *bacillus coli, bacillus cloacæ,* transitional colon bacilli, other aërobes, a non-spore-bearing bacillus of a probable anaërobic type and fungi were isolated. The pleural part of the pleuro-peritoneal cavity contained fewer bacteria, but the species represented were practically the same as those found in the other part of the cavity, except for the addition of a streptothrix. From 1,351 to countless bacteria were picked up by the pledget of cotton which was passed over the walls of the pleural cavities. The heart blood contained from 0 to 48 bacteria per loop of blood (loop = 3 m.m. diameter) consisting of streptococci, *staphylococcus albus, bacillus subtilis,* cocci, non-zymogenic bacilli and moulds.

One bird of this series was immersed in water for twenty-four hours, and after further exposure to 72° F. for twenty-four hours it was examined with the following results: the pectoralis yielded 2,261 bacteria per gram; the thigh at the middle of the femur, 197; the leg, 169; the heart blood, 3,315 per loop (loop = about 3 m.m. diameter); and both the peritoneal and pleural parts of the pleuro-peritoneal cavity gave much larger numbers than were yielded by birds thawed at room temperature, but with both kinds the organisms were countless.

The autopsy records of the drawn and undrawn chickens thawed in cold water by complete immersion for twenty-four hours and then subsequently exposed to 72° F. for twenty-four hours are herewith presented: the heads of both were discolored by initial mortification; the necks of both were brownish-red in color along the course of the jugular veins and greenish along the course of the gullet to the crop; the crop of neither had been removed, and this organ as seen through the skin was of moderately deep green color; the under side of both wings of both were reddish-brown along the course of the veins; the same condition was observed in both birds along the course of the subclavian veins; and, finally, the knees of both were reddish-brown.

Briefly stated, primary decomposition due to bacterial action was taking place along the course of the blood vessels which offered paths of least resistance to the bacteria, and this condition explains the high infection of the heart blood, as reported above. The undrawn chicken gave off odors of decomposition from the neck, head and skin; the feces were odorless; the liver was normal in appearance; the heart was abnormal, on account of a marked fatty infiltration of the tissues, and there was a heavy infection with subcutaneous calcified parasitic arachnoidea. The drawn chicken was in the same condition, excepting as to the internal organs that had been removed. The pectoralis, leg, thigh, heart, blood and the pleuro-peritoneal cavity, in other words, the entire body, was heavily infected with intestinal bacteria, mostly of the aërobic non-spore-bearing class. The thigh, which is close to the pleuro-peritoneal cavity, with only the thin abdominal muscles and the peritoneum intervening, was heavily infected with intestinal bacteria, and so was the pleuro-peritoneal cavity. The leg was but slightly infected with intestinal bacteria, and the pectoralis of the undrawn chicken was infected with diplococci only.

The conclusion to be drawn from the comparative studies of drawn and undrawn chickens kept under identical conditions is that the extent of decomposition at the end of the first twenty-four hours' exposure is greater in the drawn than in the undrawn.

One chicken of this series was thawed at room temperature and exposed for forty-eight hours at 72° F., and then examined. The crop and gullet, as far as the angle formed by the bones of the lower jaw, were pale green; through the skin was seen a brownish-red color along the course of the blood vessels of the neck; the knee joints were reddish-brown; but the under side of the wings, the legs, and in fact all the rest of the exterior of the carcass, were normal. From the body cavity were given off moderately sour, offensive odors, indicative of putrefaction. The pectoralis was infected with micrococci only; the coracoid muscles with micrococci and non-zymogenic bacteria; the subclavius, abdominal muscles and the pleuro-peritoneal cavity were moderately infected with intestinal bacteria. The pectoralis yielded 12 bacteria per gram; the subclavius, 145; the coracoid muscles, 20; the abdominal muscles, 660; and the pleuro-peritoneal cavity, vast numbers of bacteria and fungi. Every opportunity was given the aërobic bacteria for development, and, as the pleuro-peritoneal cavity was heavily seeded with intestinal aërobes during the process of drawing, decomposition in its primary stages proceeded with extreme rapidity, for aërobes are the causal agents of the primary and terminal stages of decomposition, and anaërobes of the intermediate stage.

Comparison of the Stages of Decomposition of 3 Drawn and 3 Undrawn Chickens through Six Days. (Temperature, 72° F.)

Undrawn: —

One Day. — All three birds showed a darkening of the skin along the course of the jugular veins. No odor. No discoloration of cloaca, and but a very slight discoloration of the crop region.

Two Days. — The courses of the blood vessels near the periphery were marked by a reddish-brown discoloration, which was not confined entirely to the vessels, but extended more or less into the surrounding tissues. The gullet course, the crop and cloaca had assumed a pale green color. No odor from the carcass.

Three Days. — The color changes were more marked than on the second day, and there was a very slight odor of decomposition. The skin of the legs and breast of chicken No. 3 was found to be drying rather than decomposing.

Four Days. — Chickens Nos. 1 and 2 showed a deeper shade of color change in the parts mentioned above, and, in addition, there were green patches on the sides of the thorax, on the back and over the scapulæ. From the back a heavy odor of decomposition was given off. Chicken No. 3 was dried to a greater extent, the legs and thighs being chiefly affected. There was no decomposition along the dorsal surface.

Five Days. — The first evidence of fermentative changes was found on the fifth day, when the crop, abdomen and cloaca were slightly distended by gas. Chicken No. 3, though giving little evidence of decomposition in color changes, was slightly inflated in the abdomen.

Six Days. — The only changes noted were a marked increase in gas production and an increase in intensity of the odors of decomposition. The intestines were greatly distended by gas, but the organs were but slightly below normal in appearance. Anaërobic decomposition without the aid of aërobes was the cause of the condition. At this stage the birds were turned over to the chemist.

Drawn: —

One Day. — The course of the jugular veins was marked by a reddish-brown discoloration of the skin; the crops were darkened or of a pale green color. More or less marked odor of decomposition was given off from the opened pleuro-peritoneal cavities.

Two Days. — Increased color changes. The odors given off from the cavities were very sour and fairly offensive.

Three Days. — The gullet tracts and crops of two chickens were black-green in color, but No. 3 still retained a moderately green color. The sides of the thorax were pale green. Very offensive odors of decomposition were given off from the skins and from the cavities.

Four Days. — The gullet course and the crop of one chicken were practically black; of another they were very dark green; while in the third they remained moderately deep green. The legs and thighs and small areas of the backs of two birds were drying, rather than decomposing. From the fatty areas of the skin, oil was being forced out by the collection of gas beneath the skin. Very offensive odors were given off from all three.

Five Days. — A general discoloration of all the birds, increased gas production beneath the skin and an increasing intensity in offensive odors were noted.

Six Days. — Unlike the condition obtaining in the undrawn chickens, we have to do with aërobic decomposition of animal tissue; and, as the aërobic bacteria accomplish the primary decomposition of meat, the extent of decomposition may necessarily be expected to be farther advanced. The external condition of the chickens was not much changed from the fifth day.

Incomplete drawing of the chickens left pieces of liver, parts of the oviducts and ovaries, all or parts of the lungs and the kidneys, and these were to a great extent rendered soft and gelatinous, and the cavities were coated throughout with slimy growths of the various bacteria. The muscles were still firm, but gave off very offensive odors of decomposition. The joints were easily separated from their attachments, which had been broken down. The bone marrow was scarlet and slightly abnormal. At this point the birds were turned over to the chemist.

The freezing of the chickens caused changes that rendered the development of the bacteria in the tissues easier than would have been the case if the meat had not been frozen.

Two facts were shown conclusively in the examination: first, the blood corpuscles, with the possible exception of the nuclei of a few leucocytes, were destroyed by the freezing and thawing processes; and second, the primary lines of decomposition were along the course of the large blood vessels.

With undrawn chickens anaërobic conditions are most favorable, but the changes may be slight when the anaërobes are working alone. With drawn birds aërobic conditions are most favorable, and there are vast numbers of aërobic bacteria present to carry out the first stages of decomposition.

SUMMARY, LOT II.

Results of the Bacteriological Examination of Drawn and Undrawn Chickens of Lot II.

MUSCLE OR PART SELECTED.	Undrawn Chickens. — Numbers of Bacteria per Gram of Tissue.	Drawn Chickens. — Numbers of Bacteria per Gram of Tissue.
Pectoralis,	0 to 34,	0 to 6 (12 by 2 days' exposure, 72° F. 2,261 by 2 days' soaking and exposure).
Subclavius,	2 to 3,	0 to 20 (145 by 2 days' exposure).
Coraco-branchialis longus,	1 to 6 (971 by 2 days' exposure).	2 to 1,049 (20 by 2 days' exposure).
Thigh muscle at origin,	0 to 26,	13 to 1,311.
Thigh muscle at middle of femur.	0 to 3 (183 by immersion in water).	2 to 340.
Leg (peroneus medius),	1 to 36 (176 by immersion in water).	0 to 57.
Abdominal muscles,	0 to 6 (1,550 by 2 days' exposure).	6 to 99 (660 by 2 days' exposure).
Uropygium,	12 to 310,	4 to 6.
Caudal vertebral muscles,	4 to 18,	0 to 7.
Swab of crop cavity,	8 to 11 (bacteria swabbed out).	2 to 30.
Gizzard,	0 to 5,	Removed during drawing of bird.
Liver,	0 to 1,	Removed during drawing of bird.
Spleen,	0 to 3,	Removed during drawing of bird.
Bacteria swabbed out of peritoneal part of pleuro-peritoneal cavity.	13 to 1,732 (20,199 by immersion in water and subsequent exposure 24 hours. 13,266 by 2 days' exposure).	1 bird, 20,199; remaining birds, countless. (Countless by 2 days' exposure to 72° F.) (Same by soaking and exposure.)
Bacteria swabbed out of pleural part of pleuro-peritoneal cavity.	1 to 423 (1,705 by soaking in water 24 hours and exposure 24 hours).	1,351 to countless. (Countless by 2 days' exposure to 72° F.) (Same by soaking and exposure.)
Heart blood,	0 to 3 per loop (loop = 3 m.m. diameter).	0 to 48, 3,315 per loop (by soaking and exposure to 72° F.).

Comparative Table of the Types of Bacteria found in the Muscles and Cavities.

MUSCLE OR PART SELECTED.	Undrawn Chickens. — Varieties of Bacteria.	Drawn Chickens. — Varieties of Bacteria.
Pectoralis,	Staphylococci: albus and aureus; b. subtilis, diplococci and intestinal bacilli (transitional colon bacteria, etc.).	B. subtilis, staphylococcus albus and allied micrococci and non-zymogenic bacilli.
Subclavius,	B. subtilis and streptothrix,	Staphylococcus albus and allied groups, streptothrix, b. subtilis, transitional colon bacilli.
Coraco-branchialis longus,	B. subtilis, streptothrix and unidentified bacilli.	Staphylococci: albus, citreus; streptothrix and b. coli.
Thigh muscles at dorsal origin.	Staphylococci: albus, citreus; and fungi.	Staphylococcus albus and allied cocci, b. subtilis, b. lactis aërogenes.
Thigh muscles at middle of femur.	Staphylococcus albus, allied micrococci, b. subtilis and intestinal bacilli.	B. subtilis, staphylococcus albus and transitional colon bacilli.
Leg,	Staphylococci types of streptothrix (b. coli and other intestinal bacteria by exposure).	Streptothrix, staphylococcus albus, streptococci, b. subtilis and other aërobic bacilli.
Abdominal muscles,	Transitional colon bacilli,	Staphylococcus albus, b. coli, possible anaërobes.

Comparative Table of the Types of Bacteria found in the Muscles and Cavities — Concluded.

MUSCLE OR PART SELECTED.	Undrawn Chickens. — Varieties of Bacteria.	Drawn Chickens. — Varieties of Bacteria.
Uropygium,	Micrococci, b. subtilis, transitional colon and intestinal bacilli.	B. subtilis, staphylococci: albus, citreus; and allied cocci.
Caudal vertebral muscles,	Micrococci, staphylococcus albus, b. subtilis.	B. subtilis.
Crop cavity,	Staphylococcus albus, b. subtilis, b. ramosus and b. spinosus.	Streptococci, staphylococcus albus and streptothrix.
Gizzard,	Staphylococcus albus,	Organ removed during drawing.
Liver,	Staphylococcus albus,	Organ removed during drawing.
Spleen,	Staphylococcus albus,	Organ removed during drawing.
Peritoneal part of pleuro-peritoneal cavity.	Staphylococci: albus, citreus; b. subtilis, b. coli and like, b. cloacæ and by exposure to 72° F. anaërobic bacilli.	Streptococci, staphylococcus albus and allied cocci, sarcine types, b. coli, b. cloacæ, transitional colon bacilli, anaërobes (?), fungi.
Pleural part of pleuro-peritoneal cavity.	Staphylococci: albus, citreus, aureus and allied forms; streptococci, b. subtilis, streptothrix, moulds, b. coli, transitional colon bacilli, b. megaterium and b. butyricus.	Streptococci, staphylococcus albus and allied cocci, streptothrix, sarcine types, b. coli, b. cloacæ, transitional colon bacilli, anaërobes (?), fungi.
Heart blood,	Streptothrix, b. subtilis,	Streptococci, micrococci, staphylococcus albus, b. subtilis, moulds, non-zymogenic bacilli.

Soaking drawn and undrawn chickens in water for the purpose of thawing caused an absorption of 9 per cent. of water by weight and a general infection of the tissues with intestinal bacteria.

The comparison of the drawn and undrawn chickens that had been soaked in water and then exposed for twenty-four hours shows the drawn chickens to have been more heavily infected than the undrawn, but both had been heavily invaded by intestinal bacilli.

The comparison of a drawn and undrawn chicken, each exposed to 72° F. for two days, showed the muscles of the undrawn bird to have been more heavily invaded with bacteria than those of the drawn, but the reverse was true of the pleuro-peritoneal cavities.

The major part of the decomposition of the drawn chicken was taking place in the cavity, with the result that this bird was decomposed to a greater extent than the other.

Exposure of an undrawn chicken for five days to 72° F. brought about a more universal invasion of the tissues by intestinal bacteria than existed at the end of two days.

Exposure of three drawn and three undrawn chickens, after thawing at room temperature, to 72° F. for six days showed that the undrawn chickens decomposed less extensively than the drawn. The explanation of this fact may be that the primary decomposition is produced by aërobic bacteria, in order that intermediary stages may be carried on by the anaërobes. The condition of the drawn chickens was at the optimum for aërobic development, while in the undrawn chickens the anaërobic conditions were most favorable for the growth of anaërobes.

LOT III. — Chickens. Bought in the Public Markets.

Series E. — Undrawn.
Series F. — Drawn.

Series E. — Undrawn.

The chickens of Lot III. were purchased from various poultrymen in the public market, and submitted as soon as possible to bacteriological and chemical examination. The information whether or not each bird had been in cold storage at some time in its history was seldom obtained, and accordingly no conclusions can be drawn so far as the cold-storage problem is concerned; but the examinations give us definite information of the true condition of some of the worst-looking poultry seen in markets.

The birds exposed to the atmosphere for varying periods during the winter months cannot become decomposed to such an extent as those exposed to the warm temperatures of summer; and it must be borne in mind that the birds of this lot were obtained in cold weather, when the conditions were most unfavorable to bacterial development.

Chicken No. 1. — Weight, about 3 pounds. Sent to the laboratory on Feb. 21, 1907, wrapped in paper with No. 2 and No. 3. The general appearance was unsightly, and decomposition was evident to the sense of smell. Subcutaneous fat only moderate in amount. The muscles of the back were exposed by tearings of the skin; the left wing was broken and the skin over the area of the post patigium was slightly decomposed. The feet were normal. The subcutaneous parasite mentioned above was present. The small amount of intestinal contents was in a more or less fluid condition. Examination of the deep muscles, such as the subclavius, showed the muscle fiber striations to be normal. The pectoralis muscle yielded 10,859 bacteria per gram, *staphylococcus albus* and allied cocci, and unidentified non-zymogenic bacilli of possible intestinal origin. The subclavius yielded 1,066 bacteria per gram, of the same species as those isolated from the pectoralis. The leg muscles were dry and undecomposed, and yielded but 2 bacteria per gram, *bacillus subtilis* and another obligatory aërobe. The pleuro-peritoneal cavity contained numerous anaërobic bacilli, *bacillus butyricus* predominating, but facultative aërobes were also found.

Chicken No. 2. — Weight, about 3 pounds. The skin was much torn and the flesh showed many bruises. From the exposed muscles of the back a slightly offensive odor of decomposition was given off. The uropygium stood out prominently, on account of the emaciated condition of the carcass. The pericardium had disappeared, possibly as a result of bacterial activity; the pancreas was soft and partially decomposed; and the liver, though not decomposed to any appreciable extent, was much below normal. The intestinal contents were in fluid state, but there were found no necrotic patches on the walls of the intestine. The pectoralis yielded 188 bacteria per gram, *staphylococcus albus, staphylococcus citreus, staphylococcus aureus,* a chromogenic diplococcus, *bacillus subtilis* and two types of anaërobes. The subclavius yielded 2,862 bacteria per gram, *bacillus subtilis,* staphylococci, one spore-bearing and one non-spore-bearing anaërobe like one of the two found in the pectoralis. The leg muscles yielded 1,998 bacteria per gram, *staphylococcus albus, staphylococcus aureus, staphylococcus citreus* and one anaërobe. The liver gave 94 bacteria per gram, staphylococci and aërobic bacilli. No heat-resistant anaërobes were found in the abdominal muscles.

Chicken No. 3. — Weight, 5 pounds. Condition unsightly; many bruises and breaks in the skin. The skin over the crop showed that decomposition had gone on in that region. There was also slight evidence of decomposition of the skin of the left leg, thigh, wings and back. The pectoralis yielded 20 bacteria per gram, staphylococci, streptococci, aërobic bacilli and two facultative anaërobes. The subclavius gave 2 bacteria per gram, aërobic bacilli and *staphylococcus albus.* The thigh yielded 733 bacteria per gram, staphylococci, diplococci and *bacillus butyricus* (?). The pleuro-peritoneal cavity was in a worse condition than in the case of chickens Nos. 1 and 2.

Chicken No. 4. — Received March 6, 1907. Beyond scabies of the feet, the bird was normal. The intestines were collapsed, but normal. The pectoralis was sterile; the thigh muscle at the dorsal origin was sterile; the heart muscle contained 2 bacteria per gram, a small micrococcus and a non-zymogenic aërobe; the peritoneal part of the pleuro-peritoneal cavity contained micrococci and intestinal bacteria of the anaërobic and aërobic types; the abdominal muscles contained aërobes and anaërobes, some of which were zymogenic.

Chicken No. 5. — Weight, 2½ pounds. Bought on March 12, 1907. Appearance unsightly; color, dark brownish-red. Condition dry. Decomposition not evident. The intestines were empty. The pectoralis, leg muscles, thigh muscles at their origin, liver tissue and swabs of the peritoneum were found to yield no anaërobes. The pectoralis contained 1 bacterium per gram, a micrococcus; the leg muscles were sterile; the thigh muscles at their origin contained 8 bacteria per gram, chiefly micrococci; the liver contained 59 per gram, all micrococci; and the pledget of cotton swabbed over the peritoneum yielded 1,541 bacteria, all aërobic.

Chicken No. 6. — Weight, 2½ pounds. Purchased March 12, 1907.

Skin reddish-brown in color and closely adherent to muscles, as a result of exposure and drying. The skin over the crop was colored faintly green by the contents of that organ, but there was no other evidence of decomposition. The intestines were empty. The pectoralis yielded small numbers of obligatory aërobic bacilli; the subclavius and leg muscles were sterile; the thigh muscles yielded 2 bacilli per gram, *bacillus subtilis* and a facultative anaërobe. The pledget of cotton passed over the peritoneum yielded 289 intestinal bacteria of the facultative anaërobic type.

Chicken No. 7. — Weight, 3 pounds. Purchased March 12, 1907. The skin was dried, but there was no evidence of any decomposition. The intestines were empty. The pectoralis yielded one coccus (*staphylococcus albus*) per gram; the subclavius gave 42 bacteria per gram, *staphylococcus albus,* streptococci and bacilli of doubtful intestinal origin; the leg muscles were sterile; the thigh muscles gave 1 coccus per gram; and the peritoneal part of the pleuro-peritoneal cavity contained countless intestinal bacteria, chiefly of the facultative aërobic class. No anaërobes were demonstrated, although they were probably present.

Chicken No. 8. — Purchased April 15, 1907. The general appearance was unsightly; the neck was discolored along the course of the gullet. The skin was in a water-soaked and cheesy condition, but gave off no putrefactive odors. The cloaca was surrounded by skin of a pale green hue, indicative of decomposition in its primary stage. Examinations were made to determine the presence of bacteria capable of producing putrefaction, but there was no evidence to show that the tissues had undergone any appreciable decomposition. The pectoralis contained 33 bacteria per gram, but among them were to be found no intestinal or putrefactive bacilli. The leg muscles were sterile. The thigh muscles yielded 22 bacteria per gram, micrococci and non-zymogenic bacteria, probably from the intestine. The abdominal muscles gave 202 bacteria per gram, all of intestinal origin, but they exerted no action on dextrose. From the peritoneal part of the pleuro-peritoneal cavity 111,780 bacteria, — micrococci and intestinal facultative aërobic bacilli, but no anaërobes, — were swabbed with the pledget of cotton from the peritoneum. Tests for anaërobes in the pectoralis, leg, thigh and abdominal muscles were negative.

SERIES F. — DRAWN.

Chicken No. 9. — Sent in on April 4, 1907, with the statement that the carcass had been exposed to the air from March 11 to April 4, 1907, or a period of three and one-half weeks. There was a slight reddish-brown discoloration along the neck, back, right and left hips, left thigh, wings at the joints and the areas over the scapula; also a slight greenish color along the course of the gullet and over the crop cavity. These discolored areas corresponded very closely to those found in the chickens exposed to 72° F. in the laboratory, when the primary decomposition was along the course of the blood vessels. The oil gland had been cut into with some sharp instrument; the head had been removed and the skin tied just above the vertebræ; the feet were chopped off at the heels. The heart, lungs, kidneys, lower gullet, proventriculus, gizzard, liver, spleen and part of the oviduct and ovaries were present. The odor given off from the cavity was sour, but only slightly offensive, although there was still a trace of putrefaction. The fat, dry and dark colored, had undergone extensive post-mortem change; and the gizzard, which had been smeared with yolk from a broken egg, was coated with a more or less uniform viscid, slimy covering of bacteria and fungi. The pectoralis yielded 27 bacteria per gram, all of which were intestinal bacilli of the facultative, putrefactive aërobic class. The thigh contained 544 bacteria per gram, consisting of *staphylococcus albus* and intestinal bacteria. The leg muscles contained 1 streptothrix per gram, but no other kinds of bacteria. The peritoneal and pleural parts of the pleuro-peritoneal cavities contained countless facultative anaërobic and facultative aërobic, and some obligatory aërobic bacteria, the first two classes of which exerted putrefactive action on the viscera and tissues, as proved by the slightly offensive odors given off and the butyric acid formation. Beside the bacteria in the pleuro-peritoneal cavity, there was a most luxuriant growth of mould (*mucor sp.*) lining the margins of the ventral artificial opening and covering the walls of the cavity and the viscera in the cavity. The growth of the mould retarded the action of the bacteria present, and this and the long exposure to the cold atmosphere between March 11 and April 4, prevented any extensive decomposition of the chicken.

Each chicken, at the conclusion of the examination, was turned over to the chemist.

SUMMARY, LOT III.

One drawn and eight undrawn chickens were submitted to bacteriological and chemical examination. Of the eight undrawn, but three gave evidence of decomposition, and in these cases the putrefactive odors were of only slight intensity. The drawn chicken was heavily infected with bacteria within the pleuro-peritoneal cavity, but a copious growth of mould prevented bacterial development to a considerable degree. The low temperature of the period between March 11 and April 4 facilitated and favored the mould development, but severely retarded the bacterial growth of the putrefactive intestinal bacilli.

Results of the Bacteriological Examination

		UNDRAWN CHICKENS.—			
	CHICKEN NUMBER —	1	2	3	4
	Date received and examined, . . .	Feb. 21, 1907.	Same.	Same.	March 6, 1907.
1	Pectoralis, . .	10,859	188	20	Sterile.
2	Subclavius, . .	1,066	2,862	2	-
3	Thigh, . . .	-	-	733	Sterile.
4	Leg, ...	2	1,988	-	-
5	Abdominal muscle, .	-	-	-	-
6	Heart muscle, . .	-	-	-	2
7	Liver, . . .	-	94	-	-
8	Peritoneal part of pleuro-peritoneal cavity.	-	-	-	-
9	Pleural part of same,	-	-	-	-
10	Putrefactive odors, .	Slight.	Same.	Same.	None.
11	Condition of chicken,	Skin bruised and sl. decomposed, water soaked and dried.	Same.	Slight decomposition over leg, wing, thigh and back.	Dry and normal.

Kinds of

		1	2	3	4
12	Pectoralis, . .	S. albus, cocci, non-zymogenic bacilli.	S. albus, s. aureus, s. citreus, diplococci and 2 anaërobes.	Staphylococci, streptococci, aërobes and 2 anaërobes.	Sterile.
13	Subclavius, . .	Same.	B. subtilis, cocci, spore-bearing and non-spore-bearing anaërobes.	S. albus and, aërobic bacteria.	-
14	Thigh, . . .	-	-	Staphylococci, diplococci and b. butyricus (?).	Sterile.
15	Leg, ...	B. subtilis and other aërobes.	S. albus, s. citreus, s. aureus and one anaërobe.	-	-
16	Abdominal muscle, .	-	-	-	Aërobic and anaërobic intestinal bacteria.
17	Heart muscle, . .	-	-	-	Micrococci and non-zymogenic bacteria.
18	Liver, . . .	-	Staphylococci and aërobic bacilli.	-	-
19	Peritoneal part of pleuro-peritoneal cavity.	Anaërobes and facultative aërobes.	-	-	Micrococci, aërobic and anaërobic intestinal bacteria.
20	Pleural part of pleuro-peritoneal cavity.	-	-	-	-

of Drawn and Undrawn Chickens of Lot III.

Bacteria per Gram of Tissue.				Drawn Chicken.	
5	6	7	8	1	
March 12, 1907.	Same.	Same.	April 15, 1907.	April 4, 1907.	
1	Small numbers.	1	33	27	1
-	Sterile.	42	-	-	2
8	2	1	22	544	3
Sterile.	Sterile.	Sterile.	Sterile.	1	4
-	-	-	202	-	5
-	-	-	-	-	6
59	-	-	-	-	7
1,541 swabbed out.	289 swabbed out.	Countless numbers swabbed out.	111,780 swabbed out.	Countless numbers swabbed out.	8
-	-	-	-	Same.	9
None.	None.	None.	None.	Slightly sour and offensive.	10
Slightly dry, normal.	Slightly dark in color and sl'y dry, otherwise normal.	Slightly dry and normal.	Primary stages of decomposition only.	Same.	11

Bacteria found.

Micrococcus, no anaërobes.	Obligatory aërobes.	Staph. albus.	Aërobes.	Facultative putrefactive aërobes.	12
-	Sterile.	S. albus, streptococci and intestinal bacteria.	Cocci and intestinal bacteria.	-	13
Micrococcus, no anaërobes.	B. subtilis and fac. anaërobe.	Coccus.	-	S. albus and intestinal bacteria.	14
Sterile.	Sterile.	Sterile.	Sterile.	Streptothrix.	15
-	-	-	Intestinal bacteria.	-	16
-	-	-	-	-	17
Micrococci, no anaërobes.	-	-	-	-	18
Intestinal aërobic bacilli.	Facultative anaërobes .	Facultative aërobes, no anaërobes.	Cocci, facultative aërobes, no anaërobes.	Facultative putrefactive aërobes and anaërobes, obligatory aërobes and mould.	19
-	-	-	-	Same.	20

LOT IV. — CHICKENS. EXPOSURE AND DRAWING EXPERIMENTAL SERIES.
Series G. — Undrawn.
Series H. — Drawn (in the ordinary way).
Series I. — Properly drawn.

This lot included sixteen young hens of about the same age, bought alive and killed in the laboratory by severing the heads. They were then treated in various ways. The chickens of Series G were killed, plucked, and exposed to 68° F. for two, three, four, five and six days each, and examined bacteriologically and chemically at the end of each period of exposure. Those of Series H were drawn by removing the crop and severing the duodenum close to the gizzard, then removing the intestines and cloaca, leaving the other organs untouched. The drawing was done in a generally careless way, in simulation of the method followed by marketmen. As the early stages of decomposition may be produced by aërobic bacteria, it was reasoned that with no aërobic or anaërobic bacteria smeared over the walls of the cavity left by the removal of the viscera, no decomposition could occur; and in order to substantiate this theory, the chickens of Series I were drawn with all precautions against contamination. The crop was exposed by a ventral rather than a lateral incision, and a ligature was passed around the gullet just beneath the organ, with a sterile string some six to eight inches in length, at one end of which was a double knot loop. The gullet was then severed between the crop and the ligature; the open end, which was coated with many bacteria from the contents of the crop, was carefully seared with a hot iron; and the gullet attachments were finally cut away, so that the tube could easily be passed through the coracoid arch. Next, the ventral and posterior opening was made in the ordinary way, a sterile recurved hook was inserted, and the ventral mesentery was torn away. Finally, the hook was passed through the coracoid arch, received the loop on the string attached to the gullet, and the greater part of the viscera were quickly and easily removed through the posterior opening, the alimentary tract remaining in perfect condition, and retaining the contents of the gullet and intestine. The lungs, kidneys, ovaries and oviduct were next removed, unless the experiment demanded their presence during the exposure tests. The operation of "proper" drawing consumed about two minutes.

The exposure periods of the chickens of series H and I were the same as those of Series G, namely, two, three, four, five and six days at 72° F. All the birds of the three series were kept suspended by the feet in mid-air.

Series G. — Undrawn.

General Progressive Stages of Decomposition.

Two Days' Exposure. — A small patch of skin below the cloaca was colored a pale green, and a slight sour odor was given off from the crop; otherwise, the bird appeared normal.

Three Days' Exposure. — The dorsal surface of the bird was normal in appearance. The walls of the abdomen were swelled out by gas in the intestines, and the skin along and to the right of the median line of the abdomen was colored pale green. The cloaca was sealed by dry mucus, and the skin surrounding the same was colored moderately deep green. The ventral side of the uropygium was colored pale green, and there was a slight discoloration of the thoracic muscles of the right side. The exposed pectoralis gave off no putrefactive odors. The abdominal muscles gave off odors of decomposition, but the thigh muscles, lying in close proximity, gave off none. The liver was of a pale yellowish-brown color and of flabby consistency; the intestines were filled with gas which was held by the unruptured wall. There were about 10 cubic centimeters of fluid in the peritoneal part of the cavity, that almost completely immersed the ovaries and oviduct; it consisted of red and white corpuscles, eosinophiles in abundance, and squamous epithelial cells with very fine droplets of oil.

Four Days' Exposure. — There was no appreciable advance in the decomposition.

Five Days' Exposure. — There was noted a deepening of the green color over the crop and gullet tract; the abdomen on the right and left sides was deeply colored green, and a heavy odor of decomposition was given off from all parts.

Six Days' Exposure. — The only change was a more uniform spreading of the green color over the carcass, and a greater swelling of the body with continued gas production by the anaërobic bacteria that were growing under very favorable conditions in the chicken. The putrefactive bacteria had penetrated to practically all the muscles, which, when exposed, gave off offensive odors of decomposition.

Bacteriological Studies on the Successive Days of Exposure.

Two Days' Exposure. — The pectoralis contained 1 streptothrix per gram; the leg muscles were sterile; the thigh muscles contained micrococci and intestinal bacteria in small numbers; the peritoneal part of the pleuro-peritoneal cavity was sterile, and the pleural part contained micrococci in very small numbers, only 2 being picked up on a sterile pledget of cotton swabbed over the thoracic walls.

Three Days' Exposure. — The pectoralis was sterile; the leg muscle contained intestinal bacteria; the thigh muscles contained 3 bacteria per gram, among which were *proteus vulgaris* and intestinal bacteria; the peritoneal part of the pleuro-peritoneal cavity contained 8,442 per pledget of cotton wiped over the peritoneum, and these were *proteus vulgaris* and intestinal bacteria of facultative aërobic types; and the pleural part of the pleuro-peritoneal cavity contained 6 micrococci per pledget of cotton and anaërobic bacilli.

Four Days' Exposure. — The pectoralis was infected with streptococci; the leg muscle with 2 bacteria per gram (micrococci); the thigh muscle contained 50 bacteria per gram, — all aërobic and non-fermentative bacteria; the peritoneal part of the pleuro-peritoneal cavity contained more anaërobes than aërobes, there being but 1 aërobe picked up by the sterile pledget of cotton wiped over the walls of the cavity; the pleural part of the cavity contained numerous hay bacilli and smaller numbers of facultative anaërobes and aërobes; and the abdominal muscles contained facultative aërobic and anaërobic bacteria.

Five Days' Exposure. — On the fifth day of exposure anaërobes were found in the pectoralis and leg muscles, one species of which from the leg morphologically resembled *bacillus necrosis,* and although none was demonstrated in the thigh muscles, it may be assumed that if any were present in the pectoral and leg muscles they were present in the thigh but failed to grow, a failure frequently encountered in attempting to grow anaërobes in the fermentation tube. The peritoneal part of the pleuro-peritoneal cavity contained only 14 aërobes and the pleural part only 56 per pledget. *Proteus vulgaris* and anaërobes were in the former cavity, and *staphylococcus albus, staphylococcus aureus* and anaërobes were in the latter.

Six Days' Exposure. — There was a general infection of the tissues with anaërobes, which had become predominant in many parts and were working upon the decomposition process where the putrefactive aërobes had temporarily left off.

SERIES H. — ORDINARILY DRAWN.

General Progressive Stages of Decomposition.

Two Days' Exposure. — Beyond a slightly sour odor, coupled with a peculiar musty odor that accompanies a profuse growth of *bacillus pyocyaneus,* there was no change significant of decomposition.

Three Days' Exposure. — The viscera were coated with mould and the cloacal border had become green in color. The odor was not one of putrefaction, but a musty odor, the cause being the presence of the mould and the pyocyaneus growth.

Four Days' Exposure. — No change.

Five Days' Exposure. — Beyond the development of a slightly sour odor, no change was apparent.

Six Days' Exposure. — The bird had become very mouldy within the pleuro-peritoneal cavity, but there was no decomposition, probably because of the retarding influence of the mould.

Bacteriological Studies on the Successive Days of Exposure.

Two Days' Exposure. — The pectoralis was sterile; the leg muscle contained 1 bacillus per gram (*bacillus subtilis*); the thigh, 1 micrococcus per gram; and the peritoneal and pleural parts of the pleuro-peritoneal cavities contained countless aërobes and facultative anaërobes, among which were *bacillus pyocyaneus* in large numbers, *proteus vulgaris* and micrococci.

Three Days' Exposure. — The pectoralis contained 1 *staphylococcus albus* per gram; the leg muscle 9 aërobic bacteria per gram; the thigh muscles 1 facultative aërobe per gram; and the pleural and peritoneal parts of the pleuro-peritoneal cavities were infected with countless bacteria, including micrococci, pyocyaneus bacilli, anaërobes and a luxuriant growth of mould.

Four Days' Exposure. — The pectoralis was sterile; the leg muscles contained about 1 coccus per gram, with an occasional facultative aërobic bacillus; the thigh contained 4 bacteria per gram, including *bacillus subtilis* and *bacillus spinosus;* and the pleuro-peritoneal cavities contained countless aërobes, such as *bacillus pyocyaneus;* but these bacteria were probably becoming suppressed by the growth of the mould, which was well distributed over the interior of the carcass.

Five Days' Exposure. — *Staphylococcus albus* was found in the pectoral and leg muscles to the extent of about 1 per gram. The thigh was sterile, and the cavities were in about the same condition as on the fourth day.

Six Days' Exposure. — No change. The bird was drying, and with the abstraction of water bacterial development must necessarily begin to decline.

SERIES I. — PROPERLY DRAWN.

General Progressive Stages of Exposure.

Two Days' Exposure. — In one properly drawn chicken, that had been frozen for twenty-four hours after the removal of the crop and viscera, there was observed a green color about the head, the bird having been killed in this case by severing the blood vessels of the throat and piercing the brain; otherwise, the bird was normal and showed no evidence of decomposition. Two other chickens from which the heads had been removed gave no evidence of decomposition either by appearance or putrefactive odors.

Three Days' Exposure. — The lungs were glistening, smooth and dry; the pleuro-peritoneal cavity in the peritoneal part was dry in most parts, and the thoracic muscles were dry and hard. Oil from the fat was beginning to drip, but there was no evidence of any decomposition in appearance or in putrefactive odors.

Four Days' Exposure. — There was no evidence of decomposition in the appearance of the chicken or in putrefactive odors. The pleuro-peritoneal cavity, while the walls were still moist, had offered a surface for the growth of moulds, which were found in numerous small patches. The bird was beginning to dry.

Five Days' Exposure. — There was no decomposition. The carcass was rapidly becoming dry.

Six Days' Exposure. — At the end of six days there was no evidence of decomposition. The bird was drawn on May 30, 1907, and on Dec. 31, 1907, the bird was dry, hard, odorless and *absolutely undecomposed.*

Bacteriological Studies on the Successive Days of Exposure.

Two Days' Exposure. — (*a*) This chicken was killed by severing the blood vessels of the throat and piercing the brain. After thorough bleeding the bird was placed in cold storage and frozen for twenty-four hours, when it was removed, thawed at room temperature and exposed for two days with bird (*b*) at 68° F. The crop cavity and the surfaces around the coracoid arch were not free from bacteria, for 6 were picked up by a sterile pledget of cotton swabbed over these surfaces; *bacillus subtilis* and *staphylococcus albus* were the types found, and these are obligatory aërobes and non-putrefactive. The muscles were all sterile, but the peritoneal part of the pleuro-peritoneal cavity contained 7 bacteria per pledget of cotton, these consisting of micrococci and streptothrix, probably from the air, for the number is too small to represent an infection from the intestinal tract.

(*b*) This chicken was killed by severing the head and bleeding in the usual way. The drawing was accomplished by ligature of the gullet, searing the cut end and removal of the viscera in the way described above. The pectoralis and leg remained sterile; the thigh muscle, although containing only 2 bacteria per gram capable of growing on agar under aërobic conditions, was infected with anaërobes, whose source cannot be accounted for, unless by possible infection with anaërobes from the peritoneal part of the pleuro-peritoneal cavity, which had become infected by the oozing out of fluid from the gullet while drawing the viscera through the posterior artificial hole. *Bacillus pyocyaneus* was present with anaërobic bacilli, the former occurring to the extent of 1,604 per pledget of cotton swabbed over the surfaces of the cavity. The crop cavity and the surfaces of the coracoid muscles were well coated with *bacillus pyocyaneus* and some anaërobes. As mentioned above, no decomposition had been produced.

Three Days' Exposure. — The pectoralis, leg and thigh muscles were sterile; the peritoneal and pleural parts of the pleuro-peritoneal cavity were infected with 3,672 and 748 bacteria, respectively, per pledget of cotton swabbed over the walls of the cavity at these parts. Many of the bacteria were micrococci, probably derived from the air; some were aërobic bacilli from the gullet contents, and a few were facultative anaërobes. No decomposition had been produced.

Four Days' Exposure. — Two chickens, one exposed four days, examined and turned over to the chemist, and one, during an exposure of six days, served to furnish samples for determining the condition at the end of four days' exposure. The muscles of both birds, including the pectoralis, leg and thigh muscles, were sterile, and the pleuro-peritoneal cavity was coated with mould so extensively, in one case, as to prevent a bacterial count; but in the other bird 12,587 micrococci were swabbed out with a sterile pledget of cotton. No bacilli were found. It is probable that many of the micrococci came from the air, but some were doubtless from the gullet. Neither bird was decomposed in the slightest degree.

Five Days' Exposure. — One colony of micrococcus was found on the agar plates made from the test of the pectoralis and thigh muscles respectively, but these are of no significance. The leg muscles were sterile. The cavities were slightly coated with mould, but in general the walls were quite dry. There was no decomposition.

Six Days' Exposure. — The muscles, including the pectoralis, leg and thigh, were sterile and were drying up at this period. The pleuro-peritoneal cavity was dry except in small patches, which were covered by growths of mould. The date of the examination was June 5, 1907, and on Dec. 31, 1907, the bird was dry and hard like a shell, and entirely undecomposed after an exposure to 68° F., 80° F. and higher for seven months.

SUMMARY, LOT IV.

It was found on exposure that the undrawn chickens were decomposed at a relatively rapid rate, the chickens drawn in the ordinary way decomposed at a much slower rate (in cases where mould retarded bacterial growth there was no evidence of decomposition for four days), and the chickens drawn in the proper manner never decomposed. The order of decomposition of these freshly killed unfrozen chickens is the reverse of that found by the exposure of the drawn and undrawn chickens that had been kept at —14° F. for several months, in the case of which it was found that the undrawn kept better than the drawn birds. The explanation is to be found partly in the destruction of large numbers (probably over 90 per cent.) of aërobic and anaërobic putrefactive bacteria by the temperature of — 14° F., and partly as follows: —

It is reasoned that in the case of freshly killed, undrawn chickens the putrefactive aërobes that possibly carry on the primary stages of decomposition may have quickly penetrated the intestinal wall and worked their way throughout the carcass, and prepared the way for the anaërobes which possibly, wholly or partly, control the intermediate stages of decomposition. Thus, facultative aërobic and anaërobic decomposition unretarded by the destructive action of the freezing to which the bacteria of the other birds had been subjected could be more rapidly advanced than that of the corresponding undrawn frozen chickens. The ordinarily drawn chickens of Lot IV. cannot without caution be compared with the ordinarily drawn chickens that have been subjected to — 14° F. for some months, because of luxuriant growths of mould that coated the pleuro-peritoneal cavity of practically all the exposed birds. The growths of mould undoubtedly exert a retarding influence on bacterial activity, so that only approximate conclusions can be reached; but it may safely be assumed that the chickens drawn in the ordinary manner, subjected to very low temperatures, such as — 14° F., thawed and exposed to relatively warm temperatures, will decompose more rapidly than freshly killed chickens drawn in the same way but not frozen, because of the bacterial growth enormously facilitated by the melting of crystals of water, which moistens the tissues and surfaces of the pleuro-peritoneal cavity of the frozen chickens. In freshly killed, normal birds there are no fluids in the pleuro-peritoneal cavity beyond the small quantities of rapidly drying mucus and serous fluids, and these offer opportunity for bacterial growth for a short time only; so that a drying up of the bird, rather than its decomposition, may be anticipated. These facts explain the rule in the commercial world that is most carefully followed, — never to wash any poultry, whether drawn or undrawn, with water, lest it may spoil before it can be sold. There may be subtle physical changes taking place in the cells and proteid molecules which do not enter the scope of this paper, but the moistening of all the tissues of the body by melted crystals of ice which facilitate bacterial growth and the destruction of many (90 per cent. and over) bacteria by freezing are the main causes of the greater rapidity of decomposition of frozen meats as compared with unfrozen.

In the freshly killed, undrawn, unfrozen chickens there were undoubtedly over 90 per cent. more facultative aërobes and anaërobes than in the frozen, undrawn chickens from the cold storage warehouse; and, given these conditions, it is easily seen that, even with the favorable effect of moistening the tissues with melted ice, as is the case in the thawed birds from cold storage, the rate of decomposition must depend on the numbers of bacteria present, because of the possibility that the primary stages of decomposition may be produced by facultative aërobic bacilli, which were growing as best they could under the anaërobic conditions obtaining in the pleuro-peritoneal cavities where decomposition begins.

Results of the Bacteriological Examination of Drawn and Undrawn Chickens of Lot IV.

EXPOSURE PERIOD AT 68° F.	NUMBERS OF BACTERIA.					
	SERIES G. — UNDRAWN CHICKENS.					
	Pectoralis.	Leg.	Thigh.	Abdominal Muscle.	Peritoneal Part of P. P. Cavity.	Pleural Part of Same.
2 days, . .	1 per gram.	0	1 per gram.	-	0	2 swabbed out.
3 days, . .	0	Small numbers.	3 per gram.	-	8,442 swabbed out.	6
4 days, . .	Small numbers.	2 per gram.	50 per gram.	0 aërobes.	1 swabbed out.	Many bacilli.
5 days, . .	1 per gram.	0 aërobes.	0	-	14 swabbed out.	56
Bird frozen 24 hours; exposed 2 days.	-	-	-	-	-	-

Kinds of Bacteria found.

2 days, . .	Streptothrix.	0	Coccus.	-	0	Cocci.
3 days, . .	0	Facultative aërobic bacilli.	Proteus vulgaris and fac. aërobe.	-	Staph. albus, proteus vulgaris, fac. aërobe.	Cocci anaërobe.
4 days, . .	Streptococci, aërobic bacilli.	Aërobic bacilli.	-	Facultative aërobes and anaërobes.	Anaërobes and aërobes.	B. subtilis and other aërobes and anaërobes.
5 days, . .	Anaërobes.	-	0	-	Anaërobes, proteus vulgaris.	S. albus. S. aureus.
Bird frozen 24 hours; exposed to 68° F. 2 days.	-	-	-	-	-	-

Results of the Bacteriological Examination of Drawn and Undrawn Chickens of Lot IV. — Continued.

Exposure Period at 68° F.	Numbers of Bacteria.					
	Series H. — Ordinarily Drawn Chickens.					
	Pectoralis.	Leg.	Thigh.	Abdominal Muscle.	Peritoneal Part of P. P. Cavity.	Pleural Part of Same.
2 days,	0	1 per gram.	1 per gram.	-	Countless numbers.	Same.
3 days,	1 per gram.	9 per gram.	1 per gram.	-	Countless numbers.	Same.
4 days,	0	1 per gram.	4 per gram.	-	Countless numbers.	-
5 days,	1 per gram.	1 per gram.	0	-	-	-
Bird frozen 24 hours; exposed 2 days.	-	-	-	-	-	-
	Kinds of Bacteria found.					
2 days,	-	B. subtilis.	Coccus.	-	B. pyocyaneus. Putrefactive fac. anaërobes.	Same + coccus + proteus vulgaris.
3 days,	Staph. albus.	Aërobes.	Facultative aërobes.	-	Anaërobes and cocci. B. pyocyaneus.	Same.
4 days,	0	Coccus and facultative aërobes.	B. subtilis. B. spinosus.	-	Moulds. B. subtilis.	Moulds.
5 days,	Staph. albus.	Staph. albus.	-	-	Mould.	Mould.
Bird frozen 24 hours; exposed to 68° F. 2 days.	-	-	-	-	-	-

Results of the Bacteriological Examination of Drawn and Undrawn Chickens of Lot IV. — Concluded.

Exposure Period at 68° F.	Numbers of Bacteria.						
	Series I. — Properly Drawn Chickens.						
	Pectoralis.	Leg.	Thigh.	Abdominal Muscle.	Peritoneal Part of P. P. Cavity.	Pleural Part of P. P. Cavity.	Crop Cavity.
2 days,	0	0	2 per gram.	-	1,604 swabbed out.	Countless numbers.	-
3 days,	0	0	0	-	3,672 swabbed out.	748	-
4 days,	*a.* 0	0	0	-	? moulds.	? moulds.	-
	b. 0	0	0	-	12,587 swabbed out.	-	-
5 days,	1 per gram.	0	1 per gram.	-	-	-	-
Bird frozen 24 hours; exposed 2 days.	0	0	0	-	7 swabbed out.	5 same.	-

Results of the Bacteriological Examination of Drawn and Undrawn Chickens of Lot IV.

Kinds of Bacteria found.

EXPOSURE PERIOD AT 68° F.	NUMBERS OF BACTERIA.						
	SERIES I. — PROPERLY DRAWN CHICKENS.						
	Pectoralis.	Leg.	Thigh.	Abdominal Muscle.	Peritoneal Part of P. P. Cavity.	Pleural Part of P. P. Cavity.	Crop Cavity.
2 days, . .	0	0	Cocci and anaërobes.	-	Coccus, B. pyocyaneus anaërobes.	Same.	-
3 days, . .	0	0	0	-	Cocci and facultative anaërobes.	S. albus. S. citreus. Same.	-
4 days, . .	*a.* 0	0	0	-	Moulds.	Moulds.	-
	b. 0	0	0	-	Cocci only, moulds.	Moulds.	-
5 days, . .	Coccus.	0	Coccus.	-	Mould.	Mould.	-
Bird frozen 24 hours; exposed to 68° F. 2 days.	0	0	0	-	Coccus, streptothrix types.	Staph. albus.	-

LOT V. — CONTROL.

To demonstrate the sterility or other condition of normal chickens, a strong, healthy, 4-pound bird was purchased alive and chloroformed at the laboratory. The autopsy showed that the bird was normal, but that it was harboring subcutaneous parasitic arachnoidea. Extensive bacteriological studies were made of the pectoralis, leg, thigh, and the peritoneal and pleural parts of the pleuro-peritoneal cavities. All the muscles and the peritoneal part of the cavity were sterile. A swab of the left pleural sac was soaked with a small quantity of fluid blood and picked up a small piece of clotted blood originating from a rupture of the left lung; *bacillus subtilis,* a micrococcus and a small bacillus were developed and isolated from the test of this part, and it is probable that these bacteria came from the blood infected with bacteria from the lung. From our experience with other animals whose muscles, organs and cavities have been shown to be sterile when the animals are normal, and from the results of the bacteriological study of this control chicken, it may be assumed that all normal chickens in living condition possess sterile muscles and cavities.

LOT VI. — Ducks.

Series J. — Undrawn.
Series K. — Drawn.

Series J. — Undrawn.

The ducks of this lot were killed in the usual way, by severing the blood vessels of the throat and piercing the brain. With the exception of feathers on the manus of each wing, they had been completely plucked with little or no tearing or bruising.

They weighed 4 to 5 pounds, and were normal in all respects. The mucosa of the gizzard in all cases was removed with the greatest difficulty. The red blood corpuscles of all the birds had been destroyed by the freezing and thawing processes.

Determination of Bacteria.

The pectoralis contained from 0 to 16 bacteria per gram, *staphylococcus albus, staphylococcus aureus, staphylococcus citreus* and allied groups, *bacillus subtilis,* streptococci and non-zymogenic bacilli. The subclavius contained 0 to 4 bacteria per gram, *bacillus subtilis,* streptothrix and aërobic bacilli. The coracoid muscles were infected to the extent of 0 to 340 per gram, *staphylococcus albus* and related species. The thigh muscles at their dorsal origins contained from 1 to 7 bacteria per gram, while the samples selected from a part near the middle of the femur contained from 10 to 315 per gram; *staphylococcus albus* and related forms and *bacillus subtilis* were isolated from the former, and *staphylococcus albus, staphylococcus aureus, staphylococcus citreus* and allied cocci, *bacillus subtilis,* streptococci, *bacillus coli* or like and transitional colon bacilli were found in the latter. The leg muscle yielded 2 to 11 bacteria per gram, *staphylococcus albus* and other micrococci. The abdominal muscles of the left side, which are always more highly infected than those of the right, on account of the proximity of the coils of the intestines, contained from 20 to 298 bacteria per gram, *staphylococcus albus, staphylococcus citreus* and other cocci, with intestinal bacilli. The uropygium (not including the highly infected oil gland) contained 0 to 102 bacteria per gram, *staphylococcus albus* and non-zymogenic bacteria.

The caudal vertebral muscles were sterile. The crop cavity yielded from 86 to 3,625 bacteria per pledget of cotton swabbed over the tissues, *staphylococcus albus,* streptococci, sarcina forms, *bacillus coli* or like, *bacillus megaterium* and intestinal bacteria. The liver contained one bacterium per gram (*bacillus subtilis*), the spleen 5 (staphylococci) and the kidneys 7 (staphylococci). The gizzard was sterile. The peritoneal part of the pleuro-peritoneal cavity yielded from 5 to 12,076 bacteria per pledget of cotton; but in one bird countless bacteria were found, including *staphylococcus albus, staphylococcus citreus, staphylococcus aureus* and allied micrococci, streptococci, *bacillus lactis aerogenes, bacillus coli* and transitional forms thereof. No anaërobes were found.

The pleural part of the pleuro-peritoneal cavity yielded from 12 to 2,642 bacteria per pledget wiped over the surfaces of the cavity, *staphylococcus albus, staphylococcus citreus,* streptococci, *bacillus subtilis,* transitional colon bacilli and other intestinal bacteria. No anaërobes were found.

Samples of tissue selected from the pectoralis, subclavius, caudal vertebral, uropygium, leg, gizzard, liver, spleen and kidneys contained no intestinal bacteria. In one instance *bacillus coli* had penetrated as far as the thigh muscles at their dorsal origin, and in another intestinal bacilli were found in the thigh muscles at the middle of the femur; and, as was to be expected, the abdominal muscles of the same duck contained *bacillus coli* and like intestinal bacilli.

In 66 per cent. of the tests of the crop cavity the bacteria from that organ were found to have penetrated the walls and surrounding tissues. Of the tests of the peritoneal part of the pleuro-peritoneal cavity, 42.8 per cent. demonstrated the presence of intestinal bacteria outside of the intestine; 42.8 per cent. showed the presence of micrococci; and 14.4 per cent. showed bacilli of non-zymogenic character, probably from the intestine. The tests of the pleural part of the cavity showed in 60 per cent. the presence of *bacillus coli* or like bacilli, in 20 per cent. micrococci and streptococci and in 20 per cent. sterility.

SERIES K. — DRAWN.

The ducks of Series K were drawn by cutting the duodenum close to the gizzard and removing the intestine and cloaca. All other organs were left in the body. The birds were normal.

Determination of Bacteria.

The bacteria found in the pectoralis muscle ranged in number between 1 and 6 per gram, with one exception, when they numbered 2,268 per gram. *Staphylococcus citreus* and streptothrix were isolated, together with *bacillus cloacæ* or like and small numbers of aërobic bacilli. The subclavius yielded from 0 to 2 micrococci per gram. The coracoid muscles gave from 0 to 3 bacteria per gram, streptococci and transitional colon bacilli. The thigh muscles at their dorsal origin yielded 1 to 21 bacteria per gram, and at the middle of the femur 3 to 11 per gram. *Bacillus subtilis,* streptococci and *bacillus coli* were isolated from the former, and *staphylococcus aureus, staphylococcus citreus, bacillus fluorescens, bacillus subtilis* and *bacillus coli* from the latter.

The leg muscles yielded 1 to 7 bacteria per gram, *staphylococcus albus* and obligatory non-spore-bearing bacilli of undetermined species. The abdominal muscles (internal and external oblique) contained from 24 to 110 per gram, *staphylococcus albus, staphylococcus citreus,* streptococci, *bacillus coli* or like and *bacillus subtilis.* The uropygium, including parts of the oil gland, contained countless bacteria per gram, many or perhaps all of which gained entrance through the orifice of the gland teat. The caudal vertebral muscles yielded 1 to 363 bacteria per gram, the predominating species being *staphylococcus albus* and *staphylococcus citreus.* No intestinal bacilli were found in these muscles. The crop cavity gave 12 to 228 bacteria to each pledget swabbed over the tissues, *staphylococcus albus,* streptococci, streptothrix, *bacillus subtilis, bacillus coli* or like and non-zymogenic bacilli. The organs of the body were but slightly infected. The gizzard contained 0 to 2 per gram, the liver 0 to 1, and the kidneys from 1 to 54. Spore-bearing aërobes, non-spore-bearing aërobic bacilli and streptococci were found in the gizzard, micrococci were found in the liver, and *staphylococcus albus* and transitional colon bacilli were isolated from the kidneys. The peritoneal part of the pleuro-peritoneal cavity was infected with 5,644 to countless bacteria per pledget of cotton wiped over the walls, countless in 66.67 per cent. The species present included *bacillus fluorescens, bacillus pyocyaneus,* streptococci, *staphylococcus aureus, staphylococcus citreus, staphylococcus albus,* transitional colon bacilli, *bacillus butyricus* (?) and other intestinal putrefactive bacteria.

The pleural part of the pleuro-peritoneal cavity yielded from 852 to countless bacteria per pledget of cotton swabbed over the walls, countless in 33.33 per cent. The types found included *staphylococcus albus, staphylococcus citreus,* diplococci, *bacillus coli, bacillus pyocyaneus,* streptothrix and unidentified zymogenic and non-zymogenic bacteria, probably from the intestinal contents.

The pectoralis of one bird contained *bacillus cloacæ or* like bacillus, while all the remainder of the pectoral muscles tested were sterile when inoculated into the fermentation tubes. The subclavius, caudal vertebral, leg, gizzard and spleen tissues contained no intestinal bacteria with power to split dextrose. The coracoid, the thigh muscles at their dorsal origin and at the middle of the femur, the uropygium and the kidney tissues were generally found to be infected with bacteria of undoubted intestinal origin. The pleuro-peritoneal cavity, as would be expected, was heavily seeded with practically no other micro-organisms than intestinal bacteria.

SUMMARY, LOT VI.

Results of the Bacteriological Examination of Drawn and Undrawn Ducks of Lot VI.

MUSCLES OR CAVITY.	SERIES J. — UNDRAWN DUCKS.	
	Numbers of Bacteria per Gram of Tissue.	Species of Bacteria found.
Pectoralis,	0 to 16,	Staphylococcus albus, s. aureus, s. citreus and allied cocci; streptococci; b. subtilis and non-zymogenic bacilli.
Subclavius,	0 to 4,	B. subtilis, streptothrix and aërobic bacilli.
Coraco-branchialis longus,	0 to 340,	Staphylococci and allied species.
Thigh muscles at dorsal origin.	1 to 7,	B. subtilis, staphylococcus albus and related cocci.
Same at middle of femur,	10 to 315,	S. aureus, s. citreus, s. albus and allied cocci, b. subtilis, streptococci, b. coli or like and transitional colon bacilli.
Leg, peroneus medius,	2 to 11,	Staphylococcus albus and micrococci.
Abdominal muscles,	20 to 298,	Staphylococcus albus, s. citreus and micrococci and intestinal bacilli.
Uropygium, without oil gland tissue.	0 to 102,	Staphylococcus albus and non-zymogenic bacteria.
Caudal vertebral muscles,	0,	None.
Swab of crop cavity,	86 to 3,625,	S. albus, streptococci, sarcina types, b. coli or like, b. megaterium and intestinal bacteria.
Gizzard,	0,	None.
Liver,	1,	B. subtilis.
Spleen,	5,	Staphylococci.
Kidneys,	7,	Same.
Numbers of bacteria swabbed out of *peritoneal part* of p. p. cavity.	5 to 12,076, one test = countless numbers.	S. albus, s. citreus, s. aureus and related micrococci, streptococci, b. lactis aerogenes, b. coli and transitional colon bacilli. No anaërobes found.
Same from *pleural part* of cavity.	12 to 2,642, swabbed out of cavity.	Staphylococcus albus, s. citreus, streptococci, b. subtilis, transitional colon bacilli and intestinal bacteria. No anaërobes found.

Results of the Bacteriological Examination of Drawn and Undrawn Ducks of Lot VI. — Concluded.

MUSCLES OR CAVITY.	SERIES K. — DRAWN DUCKS.	
	Numbers of Bacteria per Gram of Tissue.	Species of Bacteria found.
Pectoralis, ...	2,268 in one test, 1 to 6.	Staphylococcus citreus, streptothrix, b. cloacæ or like and aërobic bacilli.
Subclavius, ...	0 to 2, . .	Micrococci.
Coraco-branchialis longus, .	0 to 3, . .	Streptococci and transitional colon bacilli.
Thigh muscles at dorsal origin.	1 to 21, . .	B. subtilis, streptococci and b. coli.
Same at middle of femur, .	3 to 11, . .	Staphylococcus aureus, s. citreus, b. fluorescens, b. coli and b. subtilis.
Leg, peroneus medius, .	1 to 7, . .	Staphylococcus albus and obligatory aërobes.
Abdominal muscles, . .	24 to 110, . .	Staphylococcus albus, s. citreus, streptococci, b. coli or like and b. subtilis.
Uropygium, without oil gland tissue.	Tissue + oil gland, countless numbers.	Many species.
Caudal vertebral muscles, .	1 to 363, . .	Staphylococcus albus and s. citreus. No intestinal bacilli.
Swab of crop cavity, . .	12 to 228, . .	Staphylococcus albus, streptococci, streptothrix, bacillus subtilis, b. coli or like and non-zymogenic bacteria.
Gizzard, ...	0 to 2, . .	Spore-bearing and non-spore-bearing aërobes and streptococci.
Liver, ...	0 to 1, . .	Micrococcus.
Spleen, ...	Not tested, . .	Not tested.
Kidneys, ...	1 to 54, . .	Staphylococcus albus and transitional colon bacilli.
Numbers of bacteria swabbed out of *peritoneal part* of p. p. cavity.	5,644 to 66⅔ per cent. of tests = countless numbers swabbed out.	B. fluorescens, b. pyocyaneus, streptococci, staphylococcus aureus, s. citreus, s. albus, transitional colon bacilli, b. butyricus (?) and other intestinal putrefactive bacteria.
Same from *pleural part* of cavity.	852 to countless numbers, 33 per cent. of tests = countless numbers.	Staphylococcus albus, s. citreus, diplococci, b. coli, b. pyocyaneus, streptothrix and intestinal bacilli.

Of the undrawn ducks, 14.3 per cent. contained countless bacteria in the peritoneal part of the pleuro-peritoneal cavity and much smaller numbers in the pleural part.

Of the drawn ducks, 66.67 per cent. contained countless bacteria in the peritoneal part of the pleuro-peritoneal cavity and 33.33 per cent. in the pleural part.

There was no appreciable difference in the numbers of bacteria in the corresponding muscles of the drawn and undrawn ducks.

On account of the prevailing aërobic conditions in the pleuro-peritoneal cavities of the drawn ducks, together with the large numbers of bacteria in the cavities whose growth would be facilitated by the moistening of the tissues due to thawing, decomposition on exposure to favorable temperatures would go on more rapidly in the drawn than in the undrawn ducks. The former contained much smaller numbers of bacteria in the pleuro-peritoneal cavities, and these, being forced to grow under anaërobic conditions, would develop very slowly even at an optimum temperature.

LOT VII. — DUCKS. PUBLIC MARKET SERIES.

The ducks of Lot VII. were purchased in the public market.

Duck No. 1. — This bird was received on March 6, 1907. It was an undrawn female, weighing about 4 pounds. Condition relatively good; no sign of decomposition. The crop had been removed; the skin along the manus of each wing was dry, but undecomposed; the intestines were collapsed; other organs were normal.

Determination of Bacteria.

The pectoralis yielded 17 bacteria per gram, non-spore-bearing bacteria of the putrefactive and probably of the anaërobic class, in company with small numbers of aërobes. The thigh muscle yielded 1,398 bacteria per gram, among which were micrococci, diplococci, *bacillus subtilis* and facultative putrefactive aërobes. The abdominal muscles yielded 1,782 bacteria per gram, including *staphylococcus albus,* micrococci and facultative anaërobic bacilli. The heart muscle was sterile.

The peritoneal part of the pleuro-peritoneal cavity was only slightly infected, for but 59 bacteria were picked up by the pledget of cotton swabbed over the walls of the cavity; these included one type of streptothrix and numerous facultative anaërobic bacilli.

Duck No. 2. — Weight, 5½ pounds. Purchased March 12, 1907. The skin of the feet and of the manus of each wing was dry. The skin of the neck was torn in three places, but was undecomposed. The liver was slightly below normal in color and consistency; the remaining organs were normal in appearance.

Determination of Bacteria.

The pectoralis was sterile. The thigh muscles contained 1,340 bacteria per gram, including anaërobic and aërobic putrefactive bacilli. The leg muscle gave 4 bacteria of obligatory aërobic types, including *bacillus ramosus.* The abdominal muscles contained 2 aërobes per gram.

but no anaërobes. The peritoneal part of the pleuro-peritoneal cavity gave up but 7 bacteria to the pledget. Anaërobes that did not show on the agar plate were numerous and active when grown in the fermentation tube.

SUMMARY, LOT VII.

These two ducks, purchased in the public market, were drying up rather than decomposing, and at the time of examination were in a fit condition for consumption. Anaërobic conditions prevailed, and as a result the aërobic bacteria were to a large extent suppressed, thus making advanced decomposition practically impossible, for there must be a co-ordinate action of both aërobes and anaërobes, the former possibly preparing the way for the latter.

Results of the Bacteriological Examination of Drawn and Undrawn Ducks of Lot VII.

MUSCLE.	UNDRAWN DUCK NO. 1.		UNDRAWN DUCK NO. 2.	
	Numbers of Bacteria per Gram.	Species of Bacteria.	Numbers of Bacteria per Gram.	Species of Bacteria.
Pectoralis,	17	Anaërobes and a few aërobes.	0	None.
Thigh,	1,398	Micrococci, diplococci, b. subtilis and facultative anaërobes.	1,434	Putrefactive aërobes and anaërobes.
Leg,	-	- -	4	Obligatory aërobes.
Abdominal muscle,	1,782	Staphylococcus albus, micrococci and facultative anaërobes.	2	Aërobes.
Heart muscle,	0	None.	-	-
Peritoneal part of pleuro-peritoneal cavity.	59 bacteria swabbed out.	Streptothrix and facultative anaërobes.	7 bacteria swabbed out.	7 aërobes and numerous anaërobes.

LOT VIII. — MISCELLANEOUS.

Goose. — Purchased March 12, 1907. Weight, 8 pounds. Undrawn. Beyond a few bruises and extensive drying of the skin, the bird was normal. There was no evidence of decomposition.

The pectoralis contained 2 bacteria of the *bacillus subtilis* type per gram; the subclavius was sterile; the leg contained a micrococcus per gram; the thigh yielded 29 bacteria per gram, including *staphylococcus albus* and non-putrefactive obligatory aërobic bacilli; and the peritoneal part of the pleuro-peritoneal cavity yielded 2,176 bacteria per pledget, among which were staphylococci and facultative non-zymogenic aërobes and anaërobes.

Turkey No. 1. — Weight, 7 pounds. Undrawn. The head, feet and manus of each wing had been chopped off, and a slit had been made in the abdomen. Beyond a general drying, the carcass was normal, no decomposition having occurred.

The pectoralis was sterile; the thigh yielded 89 obligatory aërobes per gram at the middle of the femur and 102 at the dorsal origin. The abdominal muscle gave 2 facultative aërobes per gram, and the peritoneal part of the pleuro-peritoneal cavity yielded 27 bacteria per pledget, including facultative aërobes and anaërobes.

Turkey No. 2. — Weight, 5 pounds. Undrawn. Purchased March 7, 1907. The head and feet had been removed. The skin was slightly dark in color, and very dry. The liver was slightly below normal in color, but the remaining organs, including the collapsed intestines, were normal in appearance. There was no evidence of decomposition.

The pectoralis, thigh and leg muscles were sterile. The heart muscle contained 512 bacteria per gram (species undetermined), and the peritoneal part of the pleuro-peritoneal cavity contained 22 aërobic bacteria per pledget, including *bacillus subtilis* and *bacillus butyricus* or like anaërobe.

SUMMARY OF LOT VIII.

Results of the Bacteriological Examination of Drawn and Undrawn Turkeys of Lot VIII.

MUSCLE.	UNDRAWN TURKEY NO. 1.		UNDRAWN TURKEY NO. 2.	
	Numbers of Bacteria per Gram.	Species of Bacteria.	Numbers of Bacteria per Gram.	Species of Bacteria.
Pectoralis,	0	None.	0	None.
Thigh at dorsal origin,	89	Obligatory aërobes.	0	None.
Thigh at the middle of the femur,	102	Obligatory aërobes.	-	-
Leg, peroneus medius,	-	-	0	None (moulds).
Abdominal muscle,	2	Facultative aërobes.	-	-
Heart muscle,	-	-	512	Undetermined.
Peritoneal part of pleuro-peritoneal cavity.	27 (swabbed out).	Facultative aërobes and anaërobes.	22	Bacillus subtilis and b. butyricus or like anaërobe.

GENERAL CONCLUSIONS.

1. Poultry kept at temperatures ranging from + 5° to — 14° F. undergoes no decomposition as a result of bacterial activity.
2. Freezing destroys the red and some of the white blood corpuscles.
3. Freezing temperatures as low as — 14° F. destroy a large percentage of the bacteria present, but do not affect the more resistant ones.
4. When the tissues are thawed, they become moistened by the melting

ice crystals, and in this condition bacterial growth is facilitated and decomposition of the tissues and contents of the cells is promoted.

5. In the drawn chickens placed in cold storage aërobic conditions prevailed throughout the pleuro-peritoneal cavities. The undrawn chickens showed much smaller numbers of bacteria in the pleuro-peritoneal cavities. On account of the closed cavity, partial anaërobic conditions prevailed in these birds.

In decomposing meats, putrefactive aërobic bacteria may possibly produce the primary stages and prepare the way for anaërobes which possibly control the intermediate stages of decomposition. By the combined action of both, decay is brought about, but it is probably finished by aërobic bacteria.

From these facts it appears that, given the aërobic conditions and the larger numbers of bacteria growing on the moist surfaces and tissues of a thawed drawn chicken, decomposition will proceed at a more rapid rate than with an undrawn one containing fewer bacteria existing under partial anaërobic conditions.

6. In freshly killed, unfrozen drawn chickens, the surfaces and tissues become dry within a very short time, and, although aërobic conditions prevail, the bacteria cannot grow because of lack of moisture.

7. In freshly killed, unfrozen and undrawn chickens, on account of the closed pleuro-peritoneal cavities there is no drying of the tissues and surfaces, and facultative aërobic and anaërobic bacteria from the intestines rapidly cause decomposition.

8. By the removal of the viscera without the spilling of the contents of the alimentary tract decomposition can be prevented absolutely. The operation requires about two minutes.

9. Briefly stated, decomposition depends largely upon the presence of moisture in the tissues, for moisture is absolutely essential to bacterial growth. In freshly killed birds, ordinarily or properly drawn, the surfaces quickly become dry. In cold-storage birds, no matter how they are drawn, the tissues will be moist, because of the melting of the crystals of ice. If properly drawn, there would be but few bacteria present capable of causing decomposition.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

During the legislative session of 1907 no changes were made in the laws relative to the sale of food and drugs, other than an increase in the annual appropriation, which made possible the employment of an additional inspector. The Board lost the services of Mr. Albert E. Leach, chief analyst, who, after nine years of conspicuously able service, was compelled by ill health to resign and seek the more congenial climate of Colorado, where he has accepted a similar appointment. The vacancy so created was filled by the promotion of the first assistant analyst, Mr. Hermann C. Lythgoe.

At the close of the period covered by this report the force engaged in the food and drug work of the Board comprised the following persons: —

HERMANN C. LYTHGOE,	*Chief Analyst.*
CHARLES H. HICKEY,	*First Assistant Analyst.*
LEWIS I. NURENBERG,	*Second Assistant Analyst.*
CLARENCE E. MARSH,	*Third Assistant Analyst.*
JOHN H. TERRY,	*Inspector.*
HORACE F. DAVIS,	*Inspector.*
DANIEL E. McCARTHY,	*Inspector.*
FREDERICK L. MARION,	*Inspector.*

The report of the chief analyst presents in detail the work of this department for the year ended Nov. 30, 1907.

The number of samples examined during this period is shown in the following table, together with a summary of the work done since the passage of the law in 1882: —

Food and Drug Inspection (1882–1907).

Summary.	Years.	
	1906.	Total 1882-1907.
Number of samples of milk examined,	2,992	97,063
Number of samples above standard,	2,000	61,750
Number of samples below standard,	992	35,313
Number of samples of other kinds of food examined (not milk),	1,648	61,337
Number of samples of good quality,	1,332	50,049
Number of samples adulterated, as defined by the statutes,	316	11,288
Number of samples of drugs examined,	1,044	18,274
Number of samples of good quality,	806	11,642
Number of samples adulterated, as defined by the statutes,	238	6,632
Total examination of food and drugs,	5,684	176,674
Total samples of good quality,	4,138	123,441
Total samples not conforming to the statutes,	1,546	52,233

Section 7 of chapter 75 of the Revised Laws provides that the State Board of Health "shall annually report to the general court the number of prosecutions made under the provisions of sections sixteen to twenty-seven, inclusive, and an itemized account of the money expended in carrying out the provisions thereof;" and in accordance with this provision the following report is made.

Section 6 of chapter 386 of the Acts of 1906, "An Act relative to the labelling of certain patent or proprietary drugs and foods," provides, furthermore, that it "shall be the duty of the state board of health to cause the prosecution of all persons violating the provisions of this act;" and inasmuch as this duty is performed by the food and drug department of the Board, and under the annual appropriation therefor, no special appropriation having been provided, the prosecutions made under the provisions of this act are included.

The total number of prosecutions entered during the fiscal year ended Nov. 30, 1907, was 333, of which 289 were made under the provisions of sections 16 to 27, inclusive, of chapter 75 of the Revised Laws, and 44 under those of chapter 386 of the Acts of 1906. Of the latter, 40 were for the sale of preparations containing cocaine, 2 for the sale of cocaine without prescription, and 2 for the sale of "opium habit cures" containing a large amount of morphine; 38 of the defendants were convicted and 6 were acquitted.

Of the total number of prosecutions made, 290 resulted in conviction, 23 in acquittal; 17 were *nol-pros'd* on a legal technicality after indictment by the grand jury of Suffolk County; 2 were dismissed on motion of the inspector; 1 is pending in the lower court; and 14 are pending on appeal to the Superior Court.

The amount paid in fines was $6,546, which brings the sum total to $64,776.48.

PROSECUTIONS.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of work in 1883 (Revised Laws, chapter 75, sections 16 to 27): —

Number of Complaints entered in Court.

YEAR.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1883,	–	5	4	9	8	– [1]
1884,	2	1	45	48	44	– [1]
1885,[2]	50	1	68	119	103	– [1]
1886,[3]	10	–	10	20	19	– [1]
1887,	30	–	34	64	60	– [1]
1888,	22	–	43	65	61	$2,042 00
1889,	74	–	66	140	124	3,889 00
1890,	78	–	24	102	96	3,919 00
1891,	96	5	49	150	135	2,668 00
1892,	52	12	72	136	123	3,661 70
1893,	26	3	67	96	92	2,476 00
1894,	14	–	76	90	77	2,625 00
1895,	13	11	68	92	86	2,895 30
1896,	7	–	68	75	74	2,812 20
1897,	13	1	51	65	64	2,756 60
1898,	10	–	54	64	62	2,060 98
1899,	19	2	26	47	45	1,432 66
1900,	45	5	44	94	89	1,890 70
1901,	30	–	65	99	90	1,874 70
1902,	25	3	48	76	74	2,617 98
1903,	34	1	44	79	70	1,297 66
1904,	6	6	50	62	57	1,509 00
1905,	209	27	77	313	275	8,486 00
1906,[4]	177	60	171	409	383	7,316 00
1907,	123	63	147	333	290	6,546 00

[1] No record kept.

[2] To May 1, 1886.

[3] Four months only.

[4] Fourteen months, from Sept. 30, 1905.

The nature of the offences brought to the attention of the courts during the year, the names of the defendants, the places where the offences were committed, the dates of trial or indictment, and the results of the prosecutions, are set forth in the following table: —

For Sale of Milk not of Good Standard Quality.

NAME.	Place.	Percentage of Total Solids.	Date.	Result.
Malachi Craven,	Amesbury,	11.47	July 31, 1907,	Conviction.
Jacob H. Houghton,	Amesbury,	10.51	July 31, 1907,	Conviction.
Edward W. Page,	Amesbury,	11.53	July 31, 1907,	Conviction.
Geo. C. H. Dufton,	Andover,	11.00[1]	Oct. 4, 1907,	Conviction.
Alfred Proulx,	Andover,	10.00[2]	Oct. 4, 1907,	Conviction.
George Gorman,	Attleborough,	11.45	Apr. 2, 1907,	Conviction.
John F. Marshall,	Beverly,	11.49	May 14, 1907,	Conviction.
Joseph W. Trask,	Beverly,	11.71	May 14, 1907,	Conviction.
Henry F. Woodbury,	Beverly,	11.16	May 14, 1907,	Dismissed.[3]
Francis P. DeLory,	Billerica,	10.83	Sept. 12, 1907,	Conviction.
J. Warren Chadwick,	Boxford,	11.40	Oct. 4, 1907,	Conviction.
Earl H. Cushman,	Bridgewater,	11.08[1]	Dec. 28, 1907,	Conviction.
Warren C. Pierce,	Bridgewater,	10.64[1]	Dec. 28, 1907,	Conviction.[4]
Geo. W. Parker,	Burlington,	9.26[1]	Nov. 30, 1907,	Conviction.
George Arthur,	Canton,	8.54[1]	May 14, 1907,	Acquittal.
Alice Holland,	Chelmsford,	10.80[1]	Nov. 22, 1907,	Conviction.[4]
Louis Lampros,	Chelmsford,	10.73	Nov. 22, 1907,	Conviction.
Willard S. Parker,	Chelmsford,	11.34	Nov. 22, 1907,	Conviction.
Albert A. Wilder,	Chelsea,	10.60[1]	Oct. 24, 1907,	Acquittal.
Philip Jasmin,	Chicopee,	11.25	May 16, 1907,	Conviction.
William T. Moore,	Concord,	11.30	Aug. 3, 1907,	Conviction.
Thomas Palmer,	Danvers,	11.02	Oct. 17, 1907,	Conviction.
Geo. T. Robertson,	Danvers,	11.40	Oct. 17, 1907,	Conviction.
Joseph Lewis,	Dartmouth,	11.80	Nov. 21, 1907,	Conviction.
Manuel Perry,	Dartmouth,	11.45	Nov. 21, 1907,	Conviction.
Andrew B. Ryder,	Dartmouth,	11.45	Apr. 23, 1907,	Conviction.
William J. Smith,	Dartmouth,	11.80	Nov. 21, 1907,	Conviction.
William Whitaker,	Dartmouth,	10.70	Nov. 5, 1907,	Conviction.
George O. Williams,	Dighton,	11.02	May 13, 1907,	Conviction.
Amos P. Best,	Dracut,	9.22	June 11, 1907,	Conviction.

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[1] Addition of water alleged in complaint.

[2] Removal of cream alleged in complaint.

[3] Dismissed for want of prosecution, on motion of the inspector.

[4] Appealed to upper court; case pending.

For Sale of Milk not of Good Standard Quality — Continued.

NAME.	Place.	Percentage of Total Solids.	Date.	Result.
Herbert Andrews,	Essex,	8.32[1]	Aug. 21, 1907,	Conviction.
Herbert Andrews,	Essex,	9.48[1]	Aug. 21, 1907,	Conviction.
Herbert Andrews,	Essex,	10.71[1]	Aug. 16, 1907,	Conviction
George H. Paynter,	Essex,	10.23[1]	June 14, 1907,	Conviction.
Joseph Manghan,	Fairhaven,	11.89	Nov. 21, 1907,	Conviction.
William W. Calder,	Fall River,	11.75	Apr. 9, 1907,	Conviction.
William W. Calder,	Fall River,	11.44	Mar. 29, 1907,	Conviction.
John Crawford,	Fall River,	11.09	May 17, 1907,	Conviction.
William Crossley,	Fall River,	11.24	May 17, 1907,	Conviction.
Joshua T. Durfee,	Fall River,	10.89	May 3, 1907,	Conviction.
Frank A. Ford,	Fall River,	11.68	May 3, 1907,	Conviction.
Agastinho S. Furtado,	Fall River,	11.62	Apr. 9, 1907,	Conviction.
Cornelius J. Green,	Fall River,	11.60	Apr. 9, 1907,	Conviction.
Walter E. Peckham,	Fall River,	11.60	Mar. 29, 1907,	Conviction.
Job C. Sabens,	Fall River,	11.75	Mar. 29, 1907,	Conviction.
I. F. Silva,	Fall River,	9.75	Apr. 9, 1907,	Conviction.
John Trembly,	Fall River,	10.90	July 10, 1907,	Conviction.
Charles E. Brown,	Gardner,	11.14[1]	Jan. 19, 1907,	Conviction.
Charles E. Brown,	Gardner,	11.00	Nov. 25, 1907,	Conviction.
Leslie F. Amero,	Gloucester,	11.38	May 24, 1907,	Conviction.
William W. Brown,	Gloucester,	11.11	Aug. 16, 1907,	Conviction.[2]
William F. Marshall,	Gloucester,	11.89	May 24, 1907,	Conviction.
Thomas E. Spittle,	Gloucester,	11.20	May 24, 1907,	Conviction.
Martin Maselbos,	Ipswich,	10.46	Oct. 5, 1907,	Conviction.[2]
Martin Maselbos,	Ipswich,	10.46	Oct. 5, 1907,	Conviction.[2]
Fred Tougas,	Ipswich,	10.62	Oct. 5, 1907,	Conviction.
William C. Wallace,	Ipswich,	10.91	Oct. 5, 1907,	Conviction.[2]
Archie Dion,	Lawrence,	11.32	Oct. 4, 1907,	Conviction.
Alcide E. Lacaillade,	Lawrence,	11.72	Feb. 13, 1907,	Conviction.
John Nabed,	Lawrence,	10.00	Feb. 13, 1907,	Conviction.
John Nabed,	Lawrence,	9.60[1]	Feb. 13, 1907,	Conviction.
Leidger Pellerin,	Lawrence,	11.54	Oct. 4, 1907,	Conviction.
William E. Ralton,	Lawrence,	11.05	Oct. 4, 1907,	Conviction.
Milton J. Sawyer,	Lawrence,	11.24	Feb. 13, 1907,	Conviction.
Manuel J. Silva,	Lawrence,	11.70	Feb. 13, 1907,	Conviction.

[1] Addition of water alleged in complaint.

[2] Appealed to upper court; case pending.

For Sale of Milk not of Good Standard Quality — Continued.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Manuel J. Spinalo,	Lawrence,	11.45	Feb. 13, 1907,	Conviction.
Nelson C. Clarmont,	Lowell,	11.05	Jan. 29, 1907,	Conviction.
Eudore Croteau,	Lowell,	10.81	Jan. 29, 1907,	Conviction.
Joseph A. Ferron,	Lowell,	11.20[1]	Jan. 29, 1907,	Conviction.
Joseph A. Ferron,	Lowell,	11.20[1]	Jan. 29, 1907,	Conviction.
Joseph A. Ferron,	Lowell,	11.29[1]	Jan. 29, 1907,	Conviction.
Joseph A. Ferron,	Lowell,	11.14	May 27, 1907,	Conviction.
Arthur Gaudette,	Lowell,	11.56	Nov. 22, 1907,	Conviction.
Authee Lavoie,	Lowell,	11.28	May 27, 1907,	Conviction.
Fred W. Reed,	Lowell,	11.86	Feb. 4, 1907,	Conviction.
Charles E. Phillips,	Lynn,	11.24	Oct. 22, 1907,	Conviction.
Dennis F. Reardon,	Lynn,	11.45	Oct. 22, 1907,	Conviction.
James E. Fleet,	Marblehead,	11.30	July 18, 1907,	Conviction.
Benjamin F. Stacy,	Marblehead,	10.86	July 18, 1907,	Conviction.
Moses W. Thompson,	Merrimac,	11.60	Apr. 4, 1907,	Conviction.
Moses W. Thompson,	Merrimac,	10.40[1]	Apr. 4, 1907,	Conviction.
Joseph Lanouette,	Methuen,	11.57	Oct. 4, 1907,	Conviction.
Timothy P. Cronan,	Milford,	10.92[1]	Jan. 4, 1907,	Conviction.
Timothy P. Cronan,	Milford,	10.92[1]	Jan. 4, 1907,	Conviction.
James M. Fletcher,	Milford,	10.76[1]	Jan. 4, 1907,	Conviction.
James M. Fletcher,	Milford,	10.76[1]	Jan. 4, 1907,	Conviction.
James C. Bradway,	Monson,	10.20[2]	Aug. 22, 1907,	Pending.
Lewis R. Gifford,	New Bedford,	9.86[1]	Nov. 21, 1907,	Conviction.
Peter Oulman,	North Adams,	11.33	June 26, 1907,	Conviction.
Robert J. McQueston,	Northampton,	11.76	Dec. 11, 1907,	Conviction.
John N. Normandeau,	Northampton,	11.55	Dec. 11, 1907,	Conviction.
Nelson D. Domingue,	North Andover,	11.37	Oct. 4, 1907,	Conviction.
Frank W. Chase,	Oak Bluffs,	11.38	Sept. 3, 1907,	Acquittal.
Thorndike P. Earle,	Peabody,	11.44	May 25, 1907,	Conviction.
Arthur M. Benedict,	Pittsfield,	11.25	June 7, 1907,	Conviction.
William N. Coe,	Pittsfield,	11.43	June 7, 1907,	Conviction.
James H. Smith,	Pittsfield,	10.91	June 7, 1907,	Conviction.
Antonio C. Laura,	Raynham,	11.49	May 13, 1907,	Conviction.
Adelbert E. Batchelder,	Reading,	10.18	July 27, 1907,	Conviction.
William Dunn,	Revere,	9.76[1]	Aug. 30, 1907,	Conviction.

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[1] Addition of water alleged in complaint.
[2] Removal of cream alleged in complaint.

For Sale of Milk not of Good Standard Quality — Concluded.

NAME.	Place.	Percentage of Total Solids.	Date.	Result.
William Dunn,	Revere,	9.76[1]	Aug. 30, 1907,	Conviction.
William Mee,	Revere,	11.56	Aug. 30, 1907,	Conviction.
Walter M. Wellington,	Revere,	14.60[1]	Nov. 8, 1907,	Conviction.
Charles Bolger,	Rockport,	11.36	Aug. 16, 1907,	Conviction.
Ernest Rice,	Salem,	11.66	Jan. 5, 1907,	Conviction.
Edward H. Brown,	Springfield,	10.31[1]	Apr. 5, 1907,	Conviction.
William A. Morris,	Springfield,	10.34	May 31, 1907,	Conviction.
Mary B. Rubenstein,	Springfield,	10.92	Oct. 1907,	Conviction.
Frank S. Leighton,	Sterling,	8.60[1]	Aug. 2, 1907,	Conviction.
Newell S. Atwood,	Stoughton,	11.65	Dec. 11, 1906,	Conviction.
John Welch,	Stoughton,	11.64	Dec. 11, 1906,	Conviction.
William M. Chase,	Swansea,	10.95	Oct. 8, 1907,	Conviction.
John Davis,	Swansea,	11.64	Apr. 9, 1907,	Conviction.
Robert Foss,	Topsfield,	11.16	May 14, 1907,	Conviction.
M. B. Boudreau,	Waltham,	11.50	May 9, 1907,	Conviction.
Frank T. Donovan,	Waltham,	11.80	Apr. 1, 1907,	Conviction.
Gardner A. Teele,	Waltham,	11.03	Apr. 1, 1907,	Conviction.
James J. Leahan,	Waltham,	11.48	May 2, 1907,	Conviction.
Ralph VanWagner,	Warren,	11.27	Mar. 13, 1907,	Conviction.[2]
Gregory Tomasetti,	Watertown,	11.35	Sept. 20, 1907,	Conviction.
Alden D. Wellington,	Wayland,	11.02	Aug. 7, 1907,	Conviction.
Herman Hollander,	Westborough,	11.28	Nov. 2, 1907,	Conviction.
Charles D. Fales,	Westfield,	11.89	Nov. 26, 1907,	Conviction.
John Fowler,	Westfield,	10.72[1]	Nov. 26, 1907,	Conviction.
Edwin S. Poore,	West Newbury,	10.87[1]	July 26, 1907,	Conviction.
John A. Porter,	Woburn,	10.39	Aug. 3, 1907,	Conviction.[2]
Charles V. Swanton,	Salem, N. H.,	5.67[1]	Sept. 16, 1907,	Conviction.
Charles V. Swanton,	Salem, N. H.,	9.85[1]	Sept. 16, 1907,	Conviction.

[1] Addition of water alleged in complaint.

[2] Appealed to upper court; case pending.

For Sale of Milk containing Added Foreign Matter.

NAME.	Place.	Adulterant.	Date.	Result.
John W. Merrill,	Danvers,	Formaldehyde,	Oct. 17, 1907,	Conviction.
William Whitaker,	Dartmouth,	Boron compound,	Nov. 5, 1907,	Conviction.

For Sale of Milk containing Added Foreign Matter — Concluded.

NAME.	Place.	Adulterant.	Date.	Result.
George H. Paynter,	Essex,	Coloring matter,	June 14, 1907,	Conviction.
Edward S. Wright,	Fall River,	Coloring matter,[1]	Apr. 9, 1907,	Conviction.
Edward S. Wright,	Fall River,	Coloring matter,	Apr. 9, 1907,	Conviction.
Martin J. Whalen,	Gloucester,	Coloring matter,[1]	Mar. 4, 1907,	Conviction.
William C. Wallace,	Ipswich,	Formaldehyde,	Oct. 5, 1907,	Conviction.[2]
John C. Moynihan,	Newburyport,	Formaldehyde,[1]	July 26, 1907,	Conviction.
John C. Moynihan,	Newburyport,	Formaldehyde,[1]	July 26, 1907,	Conviction.
Nelson Marlow,	North Adams,	Formaldehyde,	July 29, 1907,	Conviction.
Mitchell J. Brouillette,	Norton,	Boron compound,	July 12, 1907,	Conviction.
William Healey,	Provincetown,	Boron compound,	Sept. 6, 1907,	Conviction.
Edward C. Pool,	Rockport,	Coloring matter,[1]	Aug. 16, 1907,	Conviction.
Edward C. Pool,	Rockport,	Coloring matter,[1]	Aug. 16, 1907,	Conviction.
Bernard J. Morlock,	Taunton,	Formaldehyde,	July 12, 1907,	Conviction.

[1] Addition of water alleged in complaint.
[2] Appealed to upper court; case pending.

For Sale of Unmarked Renovated Butter.

NAME.	Place.	Date.	Result.
Charles L. Ouimet,	Lowell,	Mar. 28, 1907,	Conviction.
Harry Pezzole,	Mansfield,	Apr. 2, 1907,	Conviction.
Rachel H. Swift,	Marlborough,	Apr. 20, 1907,	Acquittal.

For Sale of Oleomargarine as Butter.

Elbridge D. Morrow,	Worcester,	Sept. 5, 1907,	Conviction.

For Sale of Adulterated Foods other than Milk and Milk Products.

HAMBURG STEAK.

NAME.	Place.	Adulterant.	Date.	Result.
Arthur H. Atwood,	Boston,	Sodium sulphite,	Jan. 2, 1907,	Conviction.
Morris Burg,	Boston,	Sodium sulphite,	Mar. 27, 1907,	Conviction.
Walter A. Clement,	Boston,	Sodium sulphite,	June 19, 1907,	Conviction.
Ralph L. Gamaldo,	Boston,	Sodium sulphite,	Mar. 27, 1907,	Acquittal.

For Sale of Adulterated Foods other than Milk and Milk Products — Continued.

HAMBURG STEAK — *Concluded.*

NAME.	Place.	Adulterant.	Date.	Result.
Victor Guanzani,	Boston,	Sodium sulphite,	Mar. 19, 1907,	Conviction.
Isaac Mastowitz,	Boston,	Sodium sulphite,	June 19, 1907,	Conviction.
Martin J. Sherry,	Boston,	Sulphurous acid,	Jan. 22, 1907,	Conviction.
Thomas W. DeWare,	Brookline,	Sulphurous acid,	Feb. 4, 1907,	Conviction.
William A. Smith,	Cambridge,	Sulphurous acid,	Feb. 16, 1907,	Acquittal.
Lewis B. Kotarski,	Ipswich,	Sulphurous acid,	Nov. 9, 1907,	Conviction.[1]
Martin Maselbos,	Ipswich,	Sulphurous acid,	Nov. 9, 1907,	Conviction.
John J. Stack,	Lowell,	Sulphurous acid,	Mar. 15, 1907,	Conviction.
Albert Stott,	Lowell,	Sulphurous acid,	Mar. 28, 1907,	Conviction.

FRANKFORT AND VIENNA SAUSAGE AND SAUSAGE MEAT.

NAME.	Place.	Adulterant.	Date.	Result.
Nicholas Berlo,	Boston,	Boron compound,	July 3, 1907,	Conviction.
Harry P. Hinckley,	Boston,	Boron compound,	Jan. 14, 1907,	Conviction.
Marcellian Sirvian,	Boston,	Sulphurous acid,	Aug. 2, 1907,	Conviction.
Alice Marsden,	Fall River,	Boron compound,	Apr. 9, 1907,	Conviction.
John Rasmussen,	Fall River,	Boron compound,	Apr. 26, 1907,	Conviction.
Geo. E. Clark,	Lowell,	Boron compound,	Mar. 15, 1907,	Conviction.
John A. Crowe,	Lowell,	Boron compound,	Apr. 18, 1907,	Conviction.
John A. Crowe,	Lowell,	Boron compound,	Apr. 18, 1907,	Acquittal.
Edmund Fairburn,	Lowell,	Boron compound,	Apr. 25, 1907,	Conviction.
William F. Gallagher,	Lowell,	Boron compound,	Apr. 18, 1907,	Conviction.
Lowell Packing and Provision Company.	Lowell,	Boron compound,	Apr. 18, 1907,	Acquittal.
Lowell Packing and Provision Company.	Lowell,	Boron compound,	Apr. 18, 1907,	Conviction.
Daniel A. Sullivan,	Lowell,	Boron compound,	Apr. 25, 1907,	Conviction.
Amedee Tousignant,	Lowell,	Boron compound,	Mar. 5, 1907,	Conviction.
Louis Brosky & Robert E. Dufke.	New Bedford,	Boron compound,	Apr. 23, 1907,	Acquittal.

CORNED BEEF.

NAME.	Place.	Adulterant.	Date.	Result.
Patrick Canney,	Boston,	Boron compound,	Apr. 17, 1907,	Conviction.

LUNCH TONGUE.

NAME.	Place.	Adulterant.	Date.	Result.
Patrick Canney,	Boston,	Boron compound,	Apr. 17, 1907,	Conviction.

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[1] Appealed to upper court; case pending.

For Sale of Adulterated Foods other than Milk and Milk Products — Continued.

SHRIMP.

NAME.	Place.	Adulterant.	Date.	Result.
Frank W. Eaton,	Brockton,	Boron compound,	Apr. 20, 1907,	Conviction.
Oswald Bertrand,	Lowell,	Boron compound,	Mar. 15, 1907,	Conviction.
John C. McNaught,	Lowell,	Boron compound,	Mar. 28, 1907,	Conviction.
Freeman C. Spindell,	Lynn,	Boron compound,	Apr. 20, 1907,	Conviction.
John Cuttle,	Malden,	Boron compound,	Mar. 14, 1907,	Conviction.

DEVILLED HAM.

Harry P. Hinckley,	Boston,	Boron compound,	Jan. 14, 1907,	Conviction.
James McDonald,	Lowell,	Boron compound,	Mar. 5, 1907,	Conviction.
Edwin H. Hancock,	No. Attleborough,	Boron compound,	Jan. 28, 1907,	Conviction.

DEVILLED TONGUE.

Harry P. Hinckley,	Boston,	Boron compound,	Jan. 14, 1907,	Conviction.

MINCE MEAT.

Chas. H. Gretter,	Boston,	Benzoic acid,	Jan. 17, 1907,	Conviction.
Edwin C. Johnson,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Harry W. Knights,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Joseph G. MacLeod,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Walter Mitchell,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Stanislaus A. Pfeffer,	Boston,	Benzoic acid,	Jan. 4, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	Apr. 13, 1907,	Conviction.
Brockton Public Market Corporation.	Brockton,	Benzoic acid,	Jan. 3, 1907,	Conviction.
Wm. A. Smith,	Cambridge,	Benzoic acid,	Jan. 25, 1907,	Conviction.
Frederick W. Forbush,	Salem,	Benzoic acid,	Jan. 12, 1907,	Conviction.

TOMATO BOUILLON.

Harry P. Hinckley,	Boston,	Benzoic acid,	Feb. 6, 1907,	Conviction.

CHILI SAUCE.

Rufus L. Clark,	Boston,	Benzoic acid,	May 29, 1907,	Conviction.
Wm. T. Corbett,	Boston,	Benzoic acid,	Aug. 2, 1907,	Conviction.

For Sale of Adulterated Foods other than Milk and Milk Products — Continued.

SALAD DRESSING.

NAME.	Place.	Adulterant.	Date.	Result.
John J. Cahill,	Boston,	Boron compound,	Apr. 17, 1907,	Conviction.
Rufus L. Clark,	Boston,	Boron compound,	Apr. 3, 1907,	Conviction.
Edward Chevalier,	Lowell,	Boron compound,	Mar. 5, 1907,	Conviction.

"SWEET PICCALETTE."

NAME.	Place.	Adulterant.	Date.	Result.
Wm. F. Rooney,	Waltham,	Benzoic acid,	Oct. 11, 1907,	Conviction.

PICKLES.

NAME.	Place.	Adulterant.	Date.	Result.
Ervin V. Plummer,	Boston,	Alum,	Aug. 2, 1907,	Conviction.

SWEET PICKLES.

NAME.	Place.	Adulterant.	Date.	Result.
Rufus L. Clark,	Boston,	Benzoic acid,	June 25, 1907,	Acquittal.
Patrick W. Donlon,	Boston,	Benzoic acid,	July 26, 1907,	Conviction.
Ervin V. Plummer,	Boston,	Benzoic acid,	Aug. 2, 1907,	Conviction.
Martin J. Sherry,	Boston,	Benzoic acid,	Aug. 2, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	July 31, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	July 26, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	June 25, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	June 5, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	June 5, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	July 26, 1907,	Conviction.
Winthrop Brown,	Marblehead,	Benzoic acid,	July 11, 1907,	Conviction.

CIDER VINEGAR.

NAME.	Place.	Adulterant.	Date.	Result.
Frank Sundan,	Gardner,	Distilled, coloring matter.	Jan. 19, 1907,	Conviction.

PEARL ONIONS.

NAME.	Place.	Adulterant.	Date.	Result.
John E. Witherspoon,	Boston,	Benzoic acid,	June 5, 1907,	Conviction.

JAMS AND JELLIES.

NAME.	Place.	Adulterant.	Date.	Result.
Francis P. Adams,	Boston,	Benzoic acid,	May 22, 1907,	Conviction.
John E. Witherspoon,	Boston,	Benzoic acid,	June 5, 1907,	Conviction.
Melvin E. Fisher,	Brockton,	Benzoic acid,	Dec. 8, 1906,	Conviction.

For Sale of Adulterated Foods other than Milk and Milk Products — Continued.

Maple Sugar.

Name.	Place.	Adulterant.	Date.	Result.
Alemann Filippi,	Boston,	Cane sugar,	Mar. 25, 1907,	Conviction.
Alemann Filippi,	Boston,	Cane sugar,	Mar. 25, 1907,	Conviction.
John Merlino,	Boston,	Cane sugar,	Apr. 24, 1907,	Conviction.
Arthur T. Cogone,	Brookline,	Cane sugar,	Feb. 15, 1907,	Conviction.
Giacoma Magliozzi,	Dedham,	Cane sugar,	May 15, 1907,	Acquittal.
Casiano Salemme,	Dedham,	Cane sugar,	May 15, 1907,	Acquittal.
John G. Floros,	Gloucester,	Cane sugar,	June 24, 1907,	Conviction.
James Jarnesy,	Gloucester,	Cane sugar,	June 24, 1907,	Conviction.
Vorticetsa Nichols,	Gloucester,	Cane sugar,	June 14, 1907,	Conviction.
Constantine Vrahos,	Gloucester,	Cane sugar,	Aug. 9, 1907,	Conviction.
Peter Statuto,	Lowell,	Cane sugar,	June 11, 1907,	Conviction.
Vizelo Gordona,	Newton,	Cane sugar,	Apr. 20, 1907,	Conviction.
Goanna Salemme,	Newton,	Cane sugar,	Sept. 14, 1907,	Conviction.
Joseph Arcuri,	Springfield,	Cane sugar,	June 13, 1907,	Conviction.
John J. Kennedy,	Stoughton,	Cane sugar,	Dec. 15, 1906,	Conviction.
Frankie Ciacotta,	Waltham,	Cane sugar,	Apr. 12, 1907,	Conviction.

Maple Syrup.

Frank Brennan,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Charles H. Cass,	Boston,	Cane sugar,	Jan. 2, 1907,	Acquittal.
John T. Connor,	Boston,	Cane sugar,	Nov. 4, 1907,[1]	Nol-prossed.
John T. Connor Corporation.	Boston,	Cane sugar,	Nov. 4, 1907,[1]	Nol-prossed.
James J. Eagan,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Elmer E. Gray,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
E. E. Gray Co.,	Boston,	Cane sugar,	Nov. 6, 1907,[1]	Nol-prossed.
W. B. Hastings,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Acquittal.
W. B. Hastings,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Herman F. Johnson,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Thos. W. Little & Co.,	Boston,	Cane sugar,	Nov. 6, 1907,[1]	Nol-prossed.
James Morrison,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
L. W. & H. F. Morse,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Arthur V. Pettengill,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
George G. Power,	Boston,	Cane sugar,	Nov. 6, 1907,[1]	Nol-prossed.
John T. Powers & Co.,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Murray A. Smith,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.

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[1] Indictment, Suffolk County grand jury.

For Sale of Adulterated Foods other than Milk and Milk Products — Concluded.

MAPLE SYRUP — *Concluded.*

NAME.	Place.	Adulterant.	Date.	Result.
Joseph P. Spang,	Boston,	Cane sugar,	Nov. 5, 1907,[1]	Nol-prossed.
Amos T. White,	Boston,	Cane sugar,	Nov. 6, 1907,[1]	Nol-prossed.
Maxime Malo,	Lowell,	Cane sugar,	Feb. 4, 1907,	Conviction.
Frank O. Emerson,	No. Attleborough,	Cane sugar,	Feb. 11, 1907,	Conviction.

CIDER.

James Kinsley,	Acton,	Salicylic acid,	Jan. 2, 1907,	Conviction.
Charles H. Cass,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Frank C. Fox,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
William L. Hall,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
David J. Marshall,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Charles E. Munroe,	Boston,	Largely carbonated water, cane sugar and malic acid.	May 22, 1907,	Conviction.
John T. Powers,	Boston,	Benzoic acid,	Jan. 2, 1907,	Conviction.
Joseph T. Stoehr,	Boston,	Benzoic acid,	May 29, 1907,	Conviction.
Delmont E. Mowry,	Milford,	Salicylic acid,	Jan. 4, 1907,	Conviction.

CHAMPAGNE CIDER.

Ora A. Atkins,	Boston,	Largely carbonated water, cane sugar and malic acid.	Apr. 17, 1907,	Conviction.
John J. Corbett,	Boston,	Largely carbonated water, cane sugar and malic acid.	Apr. 24, 1907,	Conviction.
Herbert J. Park,	Boston,	Largely carbonated water, invert sugar and malic acid.	Apr. 10, 1907,	Conviction.

GRAPE JUICE.

Julius Hirsch,	New York,	Salicylic acid,	Jan. 8, 1907,	Acquittal.

For Sale of Adulterated Drugs.

ALCOHOL.

William A. Chaplin,	Ipswich,	Water,	Dec. 19, 1907,	Conviction.[2]

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[1] Indictment, Suffolk County grand jury.

[2] Appealed to upper court; case pending.

For Sale of Adulterated Drugs — Continued.

BEESWAX.

NAME.	Place.	Adulterant.	Date.	Result.
Charles W. Freeman,	Chelsea,	Paraffine,	Dec. 21, 1907,	Dismissed.[1]
Thomas J. Crossman,	Needham,	Paraffine,	Mar. 6, 1907,	Acquittal.

COCAINE HYDROCHLORIDE.

Thomas J. Galligan,	Boston,	Without prescription.	Sept. 25, 1907,	Acquittal.
Thomas J. Galligan,	Boston,	Without prescription.	Oct. 2, 1907,	Conviction.

EXTRACT OF JAMAICA GINGER.

Jeremiah F. Donovan,	Boston,	Deficiency in strength.	June 25, 1907,	Conviction.
Joseph Hoffman,.	Boston,	Deficiency in strength.	Aug. 2, 1907,	Conviction.
Berny Selving,	Somerville,	Deficiency in strength.	July 17, 1907,	Conviction.

OLIVE OIL.

Charles H. Knott,	Boston,	Cotton-seed oil,	Jan. 12, 1907,	Conviction.

CAMPHORATED OIL.

Benj. F. Jakeman,	Chelsea,	Deficiency in strength.	Nov. 8, 1907,	Conviction.
Joseph W. Nicklas,	New Bedford,	Deficiency in strength.	Nov. 29, 1907,	Conviction.

SPIRITS OF CAMPHOR.

Angelo Lampropoulos,	Boston,	Deficiency in strength.	Jan. 30, 1907,	Conviction.
James M. McCombie,	Boston,	Deficiency in strength.	June 19, 1907,	Acquittal.
Chas. W. Mitchell,	Boston,	Deficiency in strength.	Mar. 27, 1907,	Conviction.
Wm. H. Stanton,	Boston,	Deficiency in strength.	Mar. 12, 1907,	Conviction.
Jeffrey J. Walsh,	Fall River,	Deficiency in strength.	May 17, 1907,	Conviction.
Daniel Hirth,	Watertown,	Deficiency in strength.	Sept. 13, 1907,	Conviction.

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[1] Dismissed for want of prosecution, on motion of the inspector.

For Sale of Adulterated Drugs — Continued.

TINCTURE OF IODINE.

NAME.	Place.	Adulterant.	Date.	Result.
Frederick M. Gardner, .	Boston, . .	Low in iodine, .	Jan. 22, 1907,	Conviction.
John F. Hayes, . .	Fitchburg, .	Low in iodine, .	Dec. 26, 1907,	Conviction.[1]
Edward L. Moriarty, .	New Bedford, .	Low in iodine, .	Apr. 23, 1907,	Conviction.
Joseph W. Nicklas, .	New Bedford, .	Low in iodine, .	Nov. 29, 1907,	Conviction.

METCALF'S COCA WINE.

NAME.	Place.	Adulterant.	Date.	Result.
Francis E. Boyd, .	Boston, . .	Cocaine, . .	June 26, 1907,	Conviction.
Chas. H. Bradbury, .	Boston, . .	Cocaine, . .	June 19, 1907,	Conviction.
Guilford D. Brown, .	Boston, . .	Cocaine, . .	June 21, 1907,	Acquittal.
Samuel A. Oppe, M.D.,	Boston, . .	Cocaine, . .	June 19, 1907,	Conviction.
Frank E. Studley, .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
Sturgis C. Faxon, .	Cambridge, .	Cocaine, . .	Oct. 10, 1907,	Conviction.

MARKELL'S COCA WINE.

NAME.	Place.	Adulterant.	Date.	Result.
Daniel I. Weston, .	Chelsea, . .	Cocaine, . .	Jan. 18, 1907,	Conviction.

VIN MARIANI.

NAME.	Place.	Adulterant.	Date.	Result.
John S. Culver, . .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
Samuel Davidson, .	Boston, . .	Cocaine, . .	July 2, 1907,	Conviction.
J. Willard Haden, .	Boston, . .	Cocaine, . .	Apr. 3, 1907,	Conviction.
Martin J. McIntire, .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
Hjalmar A. Brown, .	Gloucester, .	Cocaine, . .	June 24, 1907,	Conviction.

MALTINE WITH COCA WINE.

NAME.	Place.	Adulterant.	Date.	Result.
Dennis A. Murphy, .	Adams, . .	Cocaine, . .	Oct. 2, 1907,	Conviction.
Wm. R. D. Neal, .	Boston, . .	Cocaine, . .	July 9, 1907,	Conviction.
Chas. J. Fulton, . .	Cambridge, .	Cocaine, . .	Sept. 3, 1907,	Conviction.
John B. O'Hara, .	Cambridge, .	Cocaine, . .	Oct. 4, 1907,	Conviction.
Simpson A. McConnell,	Concord, . .	Cocaine, . .	Aug. 22, 1907,	Conviction.
John D. Barry, . .	Lynn, . .	Cocaine, . .	Aug. 14, 1907,	Conviction.
James H. Mack, . .	Northampton, .	Cocaine, . .	Dec. 11, 1907,	Acquittal.
Walter J. Trembly, .	Northampton, .	Cocaine, . .	Dec. 11, 1907,	Acquittal.

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[1] Appealed to upper court; case pending.

For Sale of Adulterated Drugs — Concluded.

CATARRH REMEDIES.

NAME.	Place.	Adulterant.	Date.	Result.
Wm. G. C. Bell, . .	Boston, . .	Cocaine, . .	June 28, 1907,	Conviction.
Melvin B. Buckley, D.D.S.	Boston, . .	Cocaine, . .	Feb. 6, 1907,	Conviction.
Melvin B. Buckley, D.D.S.	Boston, . .	Cocaine, . .	Feb. 6, 1907,	Conviction.
Fred W. Connolly, .	Boston, . .	Cocaine, . .	June 6, 1907,	Conviction.
Jeremiah F. Donovan, .	Boston, . .	Cocaine, . .	June 25, 1907,	Conviction.
Thomas J. Galligan, .	Boston, . .	Cocaine, . .	Sept. 25, 1907,	Acquittal.
Thomas J. Galligan, .	Boston, . .	Cocaine, . .	Oct. 2, 1907,	Conviction.
Thomas J. Galligan, .	Boston, . .	Cocaine, . .	Oct. 2, 1907,	Conviction.
Nathan L. Graves, .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
John W. Hawkins, .	Boston, . .	Cocaine, . .	Feb. 6, 1907,	Conviction.
Abiel T. Luscomb, .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
Frank N. McDonald, .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
Timothy J. Murphy, .	Boston, . .	Cocaine, . .	June 12, 1907,	Conviction.
Percy R. Robbins, .	Boston, . .	Cocaine, . .	June 19, 1907,	Conviction.
Fredk. J. Sheehan, .	Boston, . .	Cocaine, . .	June 21, 1907,	Acquittal.
Walter Veno, . .	Boston, . .	Cocaine, . .	Feb. 6, 1907,	Conviction.
Geo. L. York, . .	Boston, . .	Cocaine, . .	June 19, 1907,	Conviction.
J. Maro Harriman, .	Lynn, . .	Cocaine, . .	Mar. 30, 1907,	Conviction.
J. Maro Harriman, .	Lynn, . .	Cocaine, . .	Mar. 30, 1907,	Conviction.
Geo. W. Carter, . .	Revere, . .	Cocaine, . .	Sept. 21, 1907,	Conviction.

OPIATE CURE.

Wm. J. Carney, . .	Melrose, . .	Morphine, . .	Feb. 28, 1907,	Conviction.
Wm. J. Carney, . .	Melrose, . .	Morphine, . .	Feb. 28, 1907,	Conviction.

Of the cases reported as pending in the last preceding report, 9 for the sale of adulterated milk resulted in conviction, fines having been imposed in all but 1 case; of 26 for the sale of adulterated foods other than milk, 1 each for the sale of adulterated buckwheat flour, jellied pigs' feet, "piccalilli," sweet pickles, maple sugar and porter, 2 each for the sale of adulterated apple butter, catsup and Chili sauce, and 13 for the sale of adulterated ale, resulted in conviction and fine; 2 cases for the sale of adulterated drugs also resulted in conviction and fine. One other case then pending is still to be tried.

The amount paid in fines was $6,546, as follows:—

Milk and milk products,	$2,683
Foods other than above,	3,047
Drugs,	816
	$6,546

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1907.

Appropriation,	$14,500 00
Salaries of analysts,	$5,459 67
Salaries of inspectors,	4,374 97
Travelling expenses and purchase of samples,	1,773 11
Apparatus and chemicals,	1,194 65
Printing,	143 41
Services, cleaning laboratory,	100 00
Express, telephone and telegraph messages,	14 73
Sundry laboratory supplies,	168 26
Typewriting supplies,	93
Books and maps,	54 76
Extra services,	327 50
Advertising,	89 48
Total,	$13,701 47

REPORT OF THE ANALYST.

By Hermann C. Lythgoe.

REPORT OF THE ANALYST.

By Hermann C. Lythgoe.

Dr. Charles Harrington, *Secretary of the Massachusetts State Board of Health.*

Dear Sir: — I herewith submit my report on the analysis of food and drugs for the year ending Nov. 30, 1907. The larger portion of this report covers the last work of Mr. Albert E. Leach as analyst of this Board, who resigned on June 22, 1907.

Milk and Milk Products.

The usual statistics of milk are as follows: —

Milk from Cities.

Cities.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with Annatto.	Number of Samples preserved with —	
							Formaldehyde.	Borax.
Beverly,	12	4	16	11.16	–	–	–	–
Boston,	33	21	54	11.70	–	–	–	–
Brockton,	66	10	76	11.70	–	–	–	–
Cambridge,	29	17	46	11.40	–	–	–	–
Chelsea,	21	24	45	11.05	–	–	–	–
Chicopee,	15	2	17	11.25	–	–	–	–
Everett,	4	12	16	11.98	–	–	–	–
Fall River,	82	37	119	8.44	–	–	–	–
Fitchburg,	46	24	70	10.80	1	–	–	–
Gloucester,	111	41	152	9.88	1	3	–	–
Haverhill,	8	10	18	10.89	–	–	–	–
Holyoke,	5	11	16	9.30	1	–	–	–
Lawrence,	36	44	80	9.60	1	–	–	–
Lowell,	100	95	195	9.22	–	–	–	–
Lynn,	38	21	59	11.14	–	–	–	–
Malden,	5	25	30	11.70	–	–	–	–
Marlborough,	17	1	18	11.90	–	–	–	–
Medford,	5	11	16	12.00	–	–	–	–
Melrose,	10	8	18	12.46	–	-	–	–
New Bedford,	62	37	99	9.86	–	–	–	2
Newburyport,	43	5	48	10.26	–	–	2	–
Newton,	18	9	27	10.07	2	–	–	–
North Adams,	44	3	47	11.33	–	–	1	–
Northampton,	3	8	11	11.55	–	–	–	–
Pittsfield,	17	3	20	10.91	–	–	–	–
Quincy,	25	9	34	11.63	–	–	–	–
Salem,	75	34	109	11.44	–	–	–	–
Somerville,	4	11	15	12.27	–	–	–	–
Springfield,	46	18	64	10.31	–	–	–	–
Taunton,	66	7	73	9.60	2	–	2	1
Waltham,	16	24	40	11.03	–	–	–	–
Woburn,	2	12	14	10.39	–	–	–	–
Worcester,	34	15	49	10.94	–	–	–	–
Summary,	1,098	613	1,711	8.44	8	3	5	3

Milk from Towns.

Towns.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with Annatto.	Number of Samples preserved with —	
							Formaldehyde.	Borax.
Abington, . .	4	6	10	11.62	–	–	–	–
Adams, . . .	14	–	14	12.48	–	–	–	–
Amesbury, . .	10	4	14	10.51	–	–	–	–
Arlington, . .	5	4	9	12.32	–	–	–	–
Athol, . . .	8	3	11	12.72	–	–	–	–
Attleborough, .	20	10	30	9.84	–	–	–	–
Braintree, . .	13	1	14	11.46	–	–	–	–
Bridgewater, .	7	3	10	10.51	–	–	–	–
Brookline, . .	16	4	20	12.23	–	–	–	–
Canton, . . .	13	1	14	8.54	1	–	–	–
Carlisle, . .	3	3	6	11.15	–	–	–	–
Clinton, . .	7	2	9	11.74	–	–	–	–
Danvers, . .	10	4	14	11.02	–	–	1	–
Dartmouth, . .	16	8	24	10.50	–	–	–	5
Dedham, . .	12	5	17	12.27	–	–	–	–
Duxbury, . .	6	–	6	12.70	–	–	–	–
Easton, . . .	9	5	14	12.09	–	–	–	–
Foxborough, .	3	–	3	13.86	–	–	–	–
Framingham, .	5	–	5	12.46	–	–	–	–
Gardner, . .	12	4	16	9.68	1	–	–	–
Greenfield, . .	18	–	18	13.00	–	–	–	–
Hingham, . .	11	3	14	11.60	–	–	–	–
Hull, . . .	5	–	5	12.11	–	–	–	–
Hyde Park, . .	34	18	52	11.20	–	–	–	–
Ipswich, . .	8	4	12	10.46	–	–	1	–
Lexington, . .	2	4	6	11.45	–	–	–	–
Mansfield, . .	8	–	8	12.63	–	–	–	–
Marblehead, . .	11	2	13	10.86	–	–	–	–
Methuen, . .	1	7	8	10.68	–	–	–	–
Milford, . .	32	6	38	12.04	–	–	–	–
Milton, . . .	1	3	4	10.73	–	–	–	–
Montague, . .	12	4	16	11.30	–	–	–	–
Nantucket, . .	18	1	19	11.91	–	–	–	–
Natick, . . .	23	3	26	11.60	–	–	–	–
No. Attleborough,	9	1	10	12.60	–	–	–	–
Oak Bluffs, . .	14	3	17	11.32	–	–	–	–
Orange, . . .	11	2	13	12.60	–	–	–	–
Palmer, . . .	4	2	6	11.70	–	–	–	–
Peabody, . .	5	8	13	12.10	–	–	–	–
Plymouth, . .	24	3	27	12.06	–	–	–	–
Provincetown, .	19	1	20	11.80	–	–	–	1
Reading, . .	24	5	29	9.80	1	–	–	–
Revere, . . .	5	5	10	9.76	–	–	–	–
Rockport, . .	10	3	13	8.80	–	2	–	–
Southbridge, .	12	6	18	11.90	–	–	–	–
Spencer, . .	13	5	18	11.24	–	–	–	–
Stoneham, . .	4	8	12	11.90	–	–	–	–
Stoughton, . .	11	3	14	12.48	–	–	–	–
Sudbury, . .	7	2	9	12.46	–	–	–	–
Swampscott, .	4	1	5	11.60	–	–	–	–
Wakefield, . .	9	3	12	11.90	–	–	–	–
Wareham, . .	12	1	13	11.55	–	–	–	–
Watertown, . .	37	12	49	11.35	–	–	–	–
Webster, . .	11	1	12	11.80	–	–	–	–
Wellesley, . .	5	1	6	12.80	–	–	–	–
Westborough, .	2	1	3	11.04	–	–	–	–
Westfield, . .	8	2	10	10.72	–	–	–	–
Weymouth, . .	5	5	10	11.68	–	–	–	–
Whitman, . .	5	2	7	12.33	–	–	–	–
Williamstown, .	8	1	9	11.70	–	–	–	–
Winchester, . .	6	5	11	9.26	–	–	–	–
Winthrop, . .	7	9	16	12.01	–	–	–	–
Summary, .	668	223	891	8.54	3	2	2	6

Milk from Suspected Producers.

LOCALITY.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.
Andover,	3	4	7	12.40
Bedford,	7	8	15	11.70
Beverly,	3	-	3	12.15
Billerica,	9	6	15	10.83
Chelmsford,	1	6	7	10.80
Clinton,	10	-	10	12.20
Concord,	2	5	7	11.30
Danvers,	15	4	19	11.00
Haverhill,	2	14	16	10.00
Methuen,	20	17	37	5.67
Monson,	-	6	6	10.20
New Bedford,	2	1	3	12.90
Sterling,	-	4	4	8.60
Waltham,	26	-	26	12.26
Warren,	3	9	12	12.27
Wayland,	17	16	33	11.02
Weston,	15	7	22	11.80
Summary,	135	107	242	5.67

Summary of Milk Statistics.

	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with Annatto.	NUMBER OF SAMPLES PRESERVED WITH —	
							Formaldehyde.	Borax.
Cities,	1,098	613	1,711	8.44	8	3	5	3
Towns,	668	223	891	8.54	3	2	2	6
Suspected producers.	135	107	242	5.67	-	-	-	-
Miscellaneous,	99	49	148	8.58	-	-	-	-
Totals,	2,000	992	2,992	5.67	11	5	7	9

Seventy-five of the miscellaneous milk samples reported were milk of known purity taken from individual cows for the purpose of making further investigation upon the refraction of the milk serum. In many cases the milk from these individual cows was below the standard, but the mixed milk of the entire herd was above the standard in most cases. The refraction of the serum prepared as described in previous reports varied from 40.5 to 45.7, while the refraction of the serum of the mixed milk was respectively 43.4, 43.6, 43.0, 42.5, 42.1 from the different herds. The analyses are not reported, as the investigation is not yet completed.

Milk colored with annatto was found in Gloucester and Rockport.

Milk preserved with formaldehyde was found in Canton, North Adams, Danvers and Ipswich. Milk containing boron preservatives was found in New Bedford, Taunton, Dartmouth and Provincetown.

The following table shows the quality of milk examined, by months: —

Quality of Milk, by Months.

	1906.	1907.											
	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	Total.
Number having more than 15 per cent. of total solids,	15	8	4	8	9	9	1	6	11	3	9	18	101
Number having between 14 and 15 per cent. of total solids,	6	16	18	11	11	19	13	14	15	6	31	52	212
Number having between 13 and 14 per cent. of total solids,	65	67	57	66	80	96	56	60	60	36	119	185	947
Number having between 12 and 13 per cent. of total solids,	54	104	49	87	114	144	108	96	195	75	155	143	1,324
Number having between 11 and 12 per cent. of total solids,	22	11	17	21	25	22	19	23	68	27	31	18	304
Number having between 10 and 11 per cent. of total solids,	5	3	–	15	3	2	3	14	17	5	8	3	78
Number having between 9 and 10 per cent. of total solids,	–	1	–	2	1	–	1	1	4	1	–	4	15
Number having between 8 and 9 per cent. of total solids,	–	–	–	1	–	2	–	4	1	–	1	–	9
Number having less than 8 per cent. of total solids,	–	–	–	–	–	–	–	1	1	–	–	–	2
Number above the standard,	87	92	79	85	214	268	179	179	281	120	159	257	2,000
Number below the standard,	80	118	66	126	29	26	22	40	91	33	195	166	992
Total,	167	210	145	211	243	294	201	219	372	153	354	423	2,992

Milk Fraudulently Adulterated.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Serum at 20°.	Foreign Substances.
M. Peason,	Lowell,	11.00	3.82	7.18	36.8	
H. F. McCartin,	Lowell,	10.94	3.70	7.24	37.0	
Joseph H. Ferron,	Lowell,	11.00	3.40	7.60	38.3	
J. C. Sabine,	Fall River,	11.75	3.85	7.90	38.9	
Joseph A. Dennis,	Fall River,	8.44	2.00	6.44	36.0	Annatto.
E. J. Barrett,	Lowell,	9.22	2.40	6.82	35.7	
Geo. H. Painter,	Essex,	10.23	2.80	7.43	37.8	Annatto.

Milk Fraudulently Adulterated — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Serum at 20°.	Foreign Substances.
Geo. H. Painter,	Essex,	10.43	2.90	7.53	38.2	Annatto.
Mitchell J. Bouillette,	East Norton,	13.89	–	–	–	Borax.
Mitchell J. Bouillette,	East Norton,	13.48	–	–	–	Borax.
Benj. J. Morlock,	Whittenton,	13.47	–	–	–	Formaldehyde.
John C. Moynihan,	Newburyport,	10.26	3.00	7.26	36.1	Formaldehyde.
John C. Moynihan,	Newburyport,	11.43	3.50	7.93	38.7	Formaldehyde.
Charles E. Brown,	Gardner,	11.14	3.50	7.64	38.1	
Joseph H. Ferron,	Lowell,	11.29	3.40	7.89	38.9	
Martin J. White,	Gloucester,	9.88	3.00	6.88	35.9	Annatto.
S. Herbert Thurston,	Haverhill,	11.08	3.20	7.88	39.2	
S. Herbert Thurston,	Haverhill,	10.89	3.30	7.54	38.3	
Leslie F. Amero,	West Gloucester,	10.80	3.10	7.70	39.2	
Leslie F. Amero,	West Gloucester,	10.65	3.20	7.45	38.9	
Leslie F. Amero,	West Gloucester,	10.60	3.20	7.40	38.6	
Leslie F. Amero,	West Gloucester,	10.54	3.20	7.34	38.5	
Moses W. Thompson,	Merrimac,	11.30	3.40	7.90	40.7	
Moses W. Thompson,	Merrimac,	11.32	3.55	7.70	40.5	
Moses W. Thompson,	Merrimac,	10.40	3.00	7.40	38.6	
Moses W. Thompson,	Merrimac,	10.74	3.40	7.34	38.4	
Moses W. Thompson,	Merrimac,	10.00	2.80	7.20	38.2	
Moses W. Thompson,	Merrimac,	10.40	3.00	7.40	37.7	
Moses W. Thompson,	Merrimac,	10.85	3.30	7.55	–	
Moses W. Thompson,	Merrimac,	10.60	3.00	7.60	–	
Moses W. Thompson,	Merrimac,	10.80	3.10	7.70	–	
Moses W. Thompson,	Merrimac,	10.40	2.80	7.60	–	
Charles L. Boutell,	Lynn,	11.14	3.40	7.74	38.9	
Walter H. Brooks,	Lawrence,	10.33	3.25	7.08	37.0	
Walter H. Brooks,	Lawrence,	10.28	3.20	7.08	36.8	
Geo. C. H. Dufton,	Andover,	11.00	3.50	7.50	38.9	
E. H. Brown,	Springfield,	10.31	2.60	7.71	38.6	
J. F. Silva,	Fall River,	9.75	3.20	6.55	35.2	
George Arthur,	Canton,	8.54	3.10	5.44	30.6	
A. M. Bennedict,	Pittsfield,	11.25	3.50	7.75	38.4	
Nelson Marlow,	North Adams,	13.02	–	–	–	Formaldehyde.
Herbert Andrews,	Essex,	10.71	3.05	7.66	38.7	

Milk Fraudulently Adulterated — Continued.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Serum at 20°.	Foreign Substances.
Frank S. Leighton,	Sterling,	8.99	3.20	5.79	33.4	
Frank S. Leighton,	Sterling,	9.13	2.90	6.23	33.9	
Frank S. Leighton,	Sterling,	8.71	2.60	6.11	33.6	
Frank S. Leighton,	Sterling,	8.60	2.50	6.10	33.4	
Edward S. Poore,	West Newbury,	10.87	3.20	7.67	38.9	
Edward C. Poole,	Rockport,	10.37	3.30	7.07	37.9	Annatto.
Edward C. Poole,	Rockport,	8.80	2.60	6.20	35.1	Annatto.
Wm. Healey,	Provincetown,	11.80	–	–	–	Borax.
Wm. Gown,	Revere,	9.76	2.60	7.16	38.0	
Walter M. Wellington,	Revere,	10.60	2.95	7.65	38.5	
John A. Porter,	Woburn,	10.44	2.85	7.59	38.5	
E. J. Noble,	Gloucester,	9.48	2.60	6.88	37.3	
Joseph C. Shepherd,	Gloucester,	8.32	2.00	6.32	35.4	
Marshall H. Gagne,	Lawrence,	10.17	3.30	6.87	36.0	
Walter B. May,	Worcester,	10.94	3.20	7.74	38.7	
Wm. C. Wallace,	Ipswich,	10.72	3.00	7.72	39.4	Formaldehyde.
Wm. C. Wallace,	Ipswich,	10.91	3.00	7.91	39.5	
Fred Tougas,	Ipswich,	10.62	3.10	7.52	38.9	
Fred Tougas,	Ipswich,	10.46	2.75	7.71	39.2	
John W. Merrill,	Danvers Center,	12.20	–	–	–	Formaldehyde.
Herman Hollander,	Westborough,	11.28	3.40	7.88	39.3	
Herman Hollander,	Westborough,	11.36	3.50	7.86	39.3	
Herman Hollander,	Westborough,	11.38	3.60	7.78	39.4	
Herman Hollander.	Westborough,	11.38	3.55	7.83	39.9	
Herman Hollander,	Westborough,	11.37	3.55	7.82	39.4	
Herman Hollander,	Westborough,	11.39	4.00	7.39	39.2	
Herman Hollander,	Westborough,	11.32	3.50	7.82	40.0	
Herman Hollander,	Westborough,	11.32	3.45	7.87	39.9	
Herman Hollander,	Westborough,	11.37	3.55	7.82	39.5	
Herman Hollander,	Westborough,	11.37	3.50	7.87	39.8	
Herman Hollander,	Westborough,	11.92	3.95	7.97	40.4	
Herman Hollander,	Westborough,	11.92	4.20	7.72	40.4	
Chas. V. Swanton,	Salem Depot, N. H.,	9.92	2.50	7.42	37.3	
Chas. V. Swanton,	Salem Depot, N. H.,	9.95	2.80	7.15	37.5	
Chas. V. Swanton,	Salem Depot, N. H.,	10.55	3.00	7.55	39.0	

Milk Fraudulently Adulterated — Concluded.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Serum at 20°.	Foreign Substances.
Chas. V. Swanton,	Salem Depot, N. H.,	9.85	2.90	6.95	37.2	
Chas. V. Swanton,	Salem Depot, N. H.,	5.67	1.80	3.87	27.2	
Chas. V. Swanton,	Salem Depot, N. H.,	10.84	3.00	7.84	39.0	
Chas. V. Swanton,	Salem Depot, N. H.,	10.86	3.10	7.76	39.4	
Chas. V. Swanton,	Salem Depot, N. H.,	10.20	3.00	7.20	38.1	
Lewis R. Gifford,	New Bedford,	9.86	2.70	7.16	35.4	
Lewis R. Gifford,	New Bedford,	10.80	3.65	7.15	36.5	
Warren A. Hathaway,	New Bedford,	10.24	2.60	7.64	36.7	Borax.
Warren A. Hathaway,	New Bedford,	11.14	2.70	8.44	38.4	Borax.
Wm. Whitaker,	Dartmouth,	11.80	3.00	8.80	42.5	Borax.
Wm. Whitaker,	Dartmouth,	11.24	2.80	8.44	42.5	Borax.
Wm. Whitaker,	Dartmouth,	11.80	3.30	8.50	42.6	Borax.
Wm. Whitaker,	Dartmouth,	10.50	2.50	8.00	39.8	Borax.
Wm. Whitaker,	Dartmouth,	10.70	2.60	8.10	41.7	Borax.
Geo. F. Noyes,	Dracut,	10.77	3.10	7.67	39.0	
Alice Holland,	Chelmsford,	10.80	3.15	7.65	38.9	
Fowler Brothers,	Westfield,	10.72	3.45	7.27	37.9	
Joseph Manghan,	East Fairhaven,	11.89	4.40	7.49	37.8	
Geo. W. Parker,	Burlington,	9.26	2.90	6.36	35.1	
Leslie G. Hill,	Lowell,	11.44	3.70	7.74	38.4	
Earl H. Cushman,	Bridgewater,	11.08	3.30	7.78	37.4	
Warren C. Pierce,	Bridgewater,	10.64	3.10	7.54	38.3	
Archie Dion,	Lawrence,	10.68	3.20	7.48	38.8	
D. C. Willard,	Greenfield,	11.30	3.50	7.80	38.4	

CREAM.

All the samples of cream examined during the year proved to be free from foreign substances.

CONDENSED MILK.

The quality of the condensed milk on the market at present is inferior to that of previous years. In our method of calculating the fat in the original milk, we assume a solid not fat of 9.3 and an ash of 0.7 in the original milk. As these figures are rather higher than those of the average milk, the fat in the original milk as reported in our tables is the highest possible figure that can consistently be given.

A study of the composition of the condensed milk on the Massachusetts market as shown by the reports of the State Board of Health during the past ten years is a convincing proof that skimming is being practised by the manufacturers. It may be seen from the following table that 60 per cent. of the condensed milk obtained in 1898 was condensed skimmed milk, and in 1899 but 2.4 per cent of the samples was condensed skimmed milk. The ratio of adulteration then gradually increased until in 1907 it was 47 per cent. The amount of skimming practised on each poor sample is not nearly so great as in 1898, for none of the poor samples examined in 1907 had less than 1.41 per cent. fat in the original milk, while in 1898 a large number of the samples was made from milk containing but a trace of fat.

It is evident from the average fat in the good samples that skimmed milk is being mixed with nearly all the milk used in making condensed milk. The average percentage of milk solids in condensed milk was about the same during all this period, yet the average percentage of fat in the good samples has fallen from 9.96 per cent. in 1898 to 7.85 per cent. in 1907. This condition of affairs is corroborated by the experience of one of our inspectors, who saw in a condensed milk factory, outside of this State, skimmed milk from a separator running into the condensing pan at the same time that whole milk was being run in.

Composition of the Average Condensed Milk during Ten Years.

YEAR.	Total Samples.	Average Fat (Per Cent.).	Good Samples.	Average Fat (Per Cent.).
1907, ...	15	6.99	8	7.85
1906, ...	32	6.97	20	7.40
1905, ...	22	7.31	15	7.89
1904, ...	43	8.09	33	8.55
1903, ...	69	8.23	60	8.42
1902, ...	64	8.73	58	8.93
1901, ...	38	8.19	30	8.50
1900, ...	42	9.59	41	9.64
1899, ...	41	10.14	40	10.19
1898, ...	48	6.20	19	9.96

Several samples of evaporated cream have been examined which should have been labelled evaporated milk. One sample should have been called evaporated skimmed milk.

The following table gives the list of adulterated brands of condensed milk: —

Composition of Adulterated Samples of Condensed Milk.

BRAND.	Manufacturer.	Fat in Original Milk (Per Cent.).
Windmill, ...	Vermont Condensed Milk Company, Richmond, Vt.	2.95
Defiance, ...	Borden's Condensed Milk Company, New York, .	2.86
Middlesex, ...	- -	2.79
Lakeside, ...	Wayne County Condensed Milk Company, Ontario Center, N. Y.	1.77
Lakeside, ...	Wayne County Condensed Milk Company, Ontario Center, N. Y.	1.73
Ontario, ...	Wayne County Condensed Milk Company, Ontario Center, N. Y.	1.44
Top Notch Evaporated Cream,	Van Camp Packing Company, Indianapolis, Ind.,	2.28

BUTTER.

Four of the 87 samples of butter examined during the year proved to be adulterated; 3 were renovated butter and 1 was oleomargarine.

FOODS EXCLUSIVE OF MILK.

The table on page 378 gives the summary of statistics of foods exclusive of milk examined during the year. Under the following headings only such foods as require special consideration will be discussed.

Baking Powder.

Two samples of baking powder were found without the necessary statements of ingredients; these samples were very old and weatherbeaten in appearance, and no doubt were shipped before the law went into effect.

Canned Fruit and Vegetables.

Four of the 27 samples were adulterated. These 4 samples consisted of Van Camp's Tomato Soup, put up by the Van Camp Packing Company, Indianapolis, Ind., and were preserved with benzoic acid.

Cider.

Forty-five samples were examined, of which 24 were adulterated, as follows: 9 were preserved with benzoic acid, 5 with salicylic acid and 10 were factitious; 2 samples of hard cider were found to be preserved, 1 with salicylic acid, the other with benzoic acid, the samples containing respectively 7.92 and 5.32 per cent. alcohol by volume. The preservatives in these cases were added to prevent acetification.

The following table shows the composition of the adulterated branded samples, together with samples of pure cider for comparison. The factitious samples were made from a cane sugar solution containing malic acid, colored with caramel, to which carbonated water was added. The methods used in making the analyses were as follows: —

Solids. — Five grams of the sample were placed in a platinum dish and evaporated on a boiling water bath for two hours and weighed. Ash: the residue obtained as above was incinerated in a muffle, and the ash weighed. Alkalinity of ash: 50 or 100 grams were evaporated in a platinum dish and the residue burned in a muffle. The ash was dissolved in cold water, filtered and washed. If any unconsumed carbon remained, the filter was placed in the dish and burned, the ash was again treated as above and the washing continued until the combined filtrates measured 200 cubic centimeters. The filtrate was treated with an excess of $\frac{N}{10}$ sulphuric acid, boiled to expel carbon dioxide, and the excess of acid determined with $\frac{N}{10}$ sodium hydroxide, phenolphthalein being used as the indicator. Express the results as cubic centimeter $\frac{N}{10}$ acid required to neutralize the ash of 100 grams of cider. Polarization: to 30 cubic centimeters of the sample 3 cubic centimeters of basic lead acetate was added, the solution filtered, the excess of lead removed from the filtrate by adding solid potassium oxalate, and the filtered solution was polarized in the 200 millimeter tube. The reading increased by 10 per cent. on account of dilution gives the direct polarization. This solution was then inverted in the usual way by adding 10 per cent. strong hydrochloric acid, and heating to 70°. This solution was then polarized, and the reading increased by 0.21 on account of the dilution gives the invert polarization.

Malic acid was detected as follows:[1] 5 cubic centimeters of the cider were treated with about 1 cubic centimeter of 10 per cent. calcium chloride solution, and made alkaline with ammonium hydroxide. The precipitate was filtered, and three volumes of alcohol added to the filtrate, which was then heated to boiling. A flocculent precipitate of calcium malate was obtained. In order to confirm this test, the precipitate was dissolved in water, a little nitric acid added and the whole evaporated to dryness. This process oxidizes the calcium malate to calcium oxalate. The residue was boiled with diluted sodium carbonate, filtered, an excess of acetic acid added, the solution boiled to expel carbon dioxide, a solution of calcium sulphate added, when a precipitate of calcium oxalate was obtained which confirmed the presence of malic acid.

Alcohol was determined in the usual way, and preservatives as described on page 369. Apple cider should have at least 0.2 per cent. of ash; the alkalinity of the ash should be at least 20, and on complete fermentation the invert polarization should be to the left, as is the direct.

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[1] Leach and Lythgoe, Jour. Am. Chem. Soc., 1904, p. 379.

Composition of Pure and Adulterated Samples of Cider.

BRAND.	Manufacturer or Wholesaler.	Solids (Per Cent.).	Ash (Per Cent.).	Alkalinity of Ash (Cubic Centimeters).	POLARIZATION, 200 MILLIMETERS (VENTZKE SCALE).		Acid.	Alcohols by Volume (Per Cent.).	Preservative.	Remarks.
					Direct.	Invert.				
Golden Russet Cider,	– –	8.32	0.27	26.4	—23.4	—23.4	Malic.	3.69	None.	Pure cider.
– –	– –	8.80	0.26	27.2	—21.0	—21.0	"	–	"	
– –	– –	1.88	0.26	27.2	—0.2	—0.2	"	6.24	"	
Hub Champagne Cider,	Hub Bottling and Extract Company, Boston.	8.93	0.01	1.0	14.6	—9.8	"	0.00	"	Made from cane sugar, malic acid and carbonated water.
Golden Russet Champagne Cider,	Standard Bottling and Extract Company, Boston.	7.20	0.03	3.0	17.6	—8.8	"	0.00	"	
Golden Seal Champagne Cider,	Otis S. Neale Company, Boston,	6.86	0.05	3.0	—3.9	—9.3	"	0.00	"	
Champagne Cider,	Leicester Polar Spring Company.	7.60	0.01	1.3	7.2	–	"	0.00	"	
Carbonated Sweet Cider,	Coleman & Keating, Boston,	11.54	0.05	1.4	—4.9	–	"	0.00	"	
Pomona Valley Company, N. C., Champagne Cider.	Lovers Leap Spring Water Company, Lynn.	6.76	0.03	3.8	14.7	–	"	0.00	"	
Russet Apple Cider,	Stoehr Bros., Boston,	4.34	0.27	26.8	6.8	0.8	"	5.32	Benzoic acid.	– –
– –	– –	2.34	0.25	23.6	—1.7	—1.7	"	7.92	Salicylic acid.	– –

Cocoa and Chocolate.

Thirty-nine samples were examined, of which 6 were adulterated: Phillips Digestible Cocoa, Charles H. Phillips Chemical Company, New York, contained cane sugar; Admiral Cocoa, Hub Cocoa Works, Boston, contained 53 per cent. cane sugar; Cocoa Cream, made by Cocoa Cream Company, contained 60 per cent. cane sugar; Eastern Breakfast Cocoa, Eastern Tea and Coffee Company, 193 Folsom Street, Boston, contained corn starch; "I-Wanta-Chocolate" contained about 25 per cent. wheat starch.

Diabetic Flour.

Three samples were examined, 2 of which conformed to the percentage of proteids stated on the package, and 1 of which did not.

Flavoring Extracts.

The following table gives the composition of the poor extracts found during the year: —

List of Inferior Flavoring Extracts.

Character of Extract.	Manufacturer or Wholesaler.	Results of Analyses.
Lemon,	Colonial Perfume and Toilet Company, Detroit, Mich.	Contained no lemon oil.
Lemon,	R. T. French Company, Rochester, N. Y.,	Contained 0.11 per cent. lemon oil.
Lemon,	Lowell Pharmacy, Lowell,	Contained 0.94 per cent. lemon oil.
Vanilla,	M. S. Mead Pharmacy, Attleborough,	Contained coumarin.
Vanilla,	D. Michaels, Boston,	Contained coumarin.
Vanilla,	L. S. B. Delaney Drug Company, Lawrence.	Contained coumarin.
Vanilla,	C. H. & H. A. Lawton, New Bedford,	Contained coumarin.
Orange,	Everett Trowbridge, Mansfield,	Contained 2.8 per cent. orange oil.
Strawberry,	Regal Extract Company, Boston,	Artificial; not marked.

Grape Juice.

Four of the 15 samples were classed as adulterated; 2 samples of "Unfermented Grape Juice," put up by Adolph Prince Company, New York, were found to be wine (10.38 per cent. of alcohol in one instance) containing a trace of salicylic acid; 1 of the same brand was found to be free from alcohol and preserved with salicylic acid. The other adulterated sample was labelled "Concentrated Unfermented Grape Juice, Guaranteed Absolutely Pure," put up by Philip J. Ritter Conserve Company, Philadelphia, Pa., and contained considerable benzoic acid.

Jams and Jellies.

Seventy samples were examined, 12 of which were classed as adulterated by reason of their being preserved without that fact being stated upon the label; in some instances they were marked "Guaranteed under the Food and Drugs Act."

The list of adulterated brands is as follows: —

Adulterated Brands of Jams and Jellies.

CHARACTER OF SAMPLE.	Manufacturer or Wholesaler.	Results of Analyses.
Wild raspberry preserves, . . .	F. P. Adams & Co., Boston.	Preserved with benzoic acid.
Preserved raspberries, . . .	Libby, McNeill & Libby, Chicago, Ill.	Preserved with benzoic acid.
Ideal strawberry and apple,[1] . .	Logan, Johnson Company, Boston.	Preserved with benzoic acid.
Strawberry preserves,[1] . . .	Lutz & Schramm Company, Allegheny, Pa.	Preserved with benzoic acid.
"Victor" wild strawberry preserves,	Saville, Somes & Co., Boston.	Preserved with benzoic acid.

Malt Liquor.

Forty-two samples of malt liquor, including ale, beer, malt extract and porter, have been examined, in only 1 of which have preservatives been found. This sample was Meux's Original London Stout, manufactured by Meux's Brewery Company, Ltd., London, Eng., and was preserved with salicylic acid; samples of subsequent importations have been found free from salicylic acid.

Maple Products.

Of 68 samples of maple sugar examined, 28 proved to be adulterated; and of 74 samples of maple syrup, 35 were adulterated, the adulterant in all cases being refined cane sugar. A large number of syrups not labelled maple syrup were classed as adulterated, as they were sold to the inspectors for maple syrup. In all these cases the wholesale dealer complied with the law, while the retail dealer did not. In the examination of the maple sugar, determinations of total ash and lead number, and in the case of maple syrup the polarization, in addition to the other determinations, were sufficient in most cases to establish the fraudulent character of the samples.

The following list contains the adulterated brands of maple syrup: —

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[1] Guaranteed under the food and drugs act.

List of Adulterated Brands of Maple Syrup.

BRAND.	Manufacturer or Wholesaler.	Cane Sugar Syrup (Per Cent.).
Pure Maple Syrup,	Lyndonville, Vt.,	90
Barker's,	J. H. Barker & Co., New York,	80 [1]
Peerless,	M. S. Ayer & Co., Boston,	80 [1]
Gold Leaf,	Huntington Maple Syrup and Sugar Company, Providence, R. I.	65 [1]
Gilt Edge,	J. G. Turner, Medford,	25
Rival,	Haskell, Adams & Co., Boston,	80 [1]
– –	F. P. Adams & Co., Boston,	30
– –	Eastern Preserving Company, Providence, R. I.,	90 [1]
My Wife's,	Fred Fear, New York,	80 [1]
Pure Vermont,	W. A. Little & Co., Andrew Square, Boston,	90

Meat Products.

There has been marked improvement in the quality of the meat products on the market over that of previous years. There have been no adulterated hogshead cheese, lamb's tongues or jellied meats this year, while last year a large number of the above-mentioned foods were adulterated. The only adulterated sample of beef extract was so reported because of the excessive amount of salt. The adulterated samples of mince meat were preserved with benzoic acid, the hamburg steak with sodium sulphite, the sausages and canned meats with boron preservatives. There is still on the market a small amount of the poor canned meat reported in the newspapers, and Board of Health Bulletin of June, 1896, as shown by an occasional sample collected, most of these samples being found in towns somewhat removed from the larger cities. This shows to a slight extent the probable age of the average canned goods in some of the country grocery stores.

The following table gives the analyses of the different brands of meat products found not to comply with the law: —

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[1] Erroneous formula.

List of Adulterated Brands of Meat Products.

CHARACTER OF SAMPLE.	Name of Manufacturer or Dealer.	Results of Analyses.
"Lawson Pink" devilled ham,	Roger J. Sherman Company, Boston.	Contained a boron preservative.
"Van Camp's" potted ham,	Van Camp Packing Company, Indianapolis, Ind.	Contained a boron preservative.
Vienna sausage,	Libby, McNeill & Libby, Chicago, Ill.	Contained a boron preservative.
"Blue Ribbon" Vienna sausage,	German-American Preserving Company, Chicago, Ill.	Contained a boron preservative.
"Veribest" Vienna sausage,	Armour & Co., Chicago, Ill.,	Contained a boron preservative.
Devilled ham,	Armour & Co., Chicago, Ill.,	Contained a boron preservative.
"Veribest" devilled ham,	Armour & Co., Chicago, Ill.,	Contained a boron preservative and corn meal.
"Veribest" devilled ox tongue,	Armour & Co., Chicago, Ill.,	Contained a boron preservative and corn meal.
"Rex" devilled chicken,	Cudahy Canning Company, U. S. A.	Contained a boron preservative.
Boar's head cheese,	Harry Peck, London, Eng.,	Contained a boron preservative.
Mince meat,	The H. & H. Mince Meat Packing Company.	Preserved with benzoic acid.
Mince meat,	Logan & Johnson Company, Boston.	Preserved with benzoic acid.
Mince meat,	George G. Fox Company, Boston,	Preserved with benzoic acid.
Mince meat,	Geo. Rust, Lynn,	Preserved with benzoic acid.

Molasses.

Five samples were examined, all of which were found free from adulteration.

Non-Alcoholic Drinks.

Twenty-three samples were examined, all of which were pure.

Pastry.

Four samples were examined, one of which was found to be adulterated. This sample was a sample of fried pie containing a fruit jelly which was preserved with benzoic acid.

Pickles.

One hundred and sixty-nine samples of pickles have been collected and examined, of which 61 contained preservatives; most of these were bulk goods sold by retail dealers in cartons. In a great many cases the wholesaler had complied with the law in marking the barrel, and instructed the retail dealer to mark packages of pickles he sold. These samples were classed as adulterated by reason of their containing either alum or benzoic acid. In the following table are given the results of the examination of bottled pickles bearing the name of the manufacturer or wholesaler: —

List of Adulterated Brands of Pickles.

BRAND.	Manufacturer or Wholesaler.	Results of Analyses.
Fancy sweet mixed pickles, A.-L.-D.-A. Brand.	Cobb, Aldrich & Co., Boston, . .	Preserved with benzoic acid.
Columbia sweet piccalette, .	Columbia Conserve Company, Indianapolis, Ind.	Preserved with benzoic acid.
Cruikshank's sweet pickles, .	Cruikshank Bros., Allegheny, Pa. .	Preserved with benzoic acid.
Sweet gherkins, . . .	Ginter Grocery Company, Boston, .	Preserved with benzoic acid.
Sweet mixed pickles, . .	Lutz & Schramm Company, Allegheny, Pa.	Preserved with benzoic acid.
Sweet gherkins, . . .	Lutz & Schramm Company, Allegheny, Pa.	Preserved with benzoic acid.
Pearl onions, ...	Lutz & Schramm Company, Allegheny, Pa.	Preserved with benzoic acid.
Diamond relish, . . .	Lutz & Schramm Company, Allegheny, Pa.	Preserved with benzoic acid.
Northside sweet pickles, .	Northside Packing Company, Cincinnati, O.	Preserved with benzoic acid.
Sweet gherkins, . . .	C. K. Sherwood, New York, . .	Preserved with benzoic acid.
Lexington brand sweet pickles.	Wason & Co., Boston, . . .	Preserved with benzoic acid.
Clinton brand pickles, . .	Alert & McGuire, New York, . .	Contained alum.
Mixed pickles, . . .	Libby, McNeill & Libby, Chicago, Ill.,	Contained alum.
Gherkins, ...	Libby, McNeill & Libby, Chicago, Ill.,	Contained alum.
Gold Medal pickles, . .	Squire, Dinger Company, Chicago, Ill.	Contained alum.
Acme pickles, . . .	J. Weller Company, Cincinnati, O.,	Contained alum.

Salad Dressing.

Thirty-three samples were examined, seven of which contained boron preservative. The adulterated brands are given in the following table.

List of Adulterated Brands of Salad Dressing.

BRAND.	Manufacturer or Wholesaler.	Results of Analyses.
"Alpha Salad Cream,"[1] . .	H. J. Blodgett & Co., Boston,	Contained a boron preservative.
Columbia Salad Dressing, . .	Columbia Conserve Company, Indianapolis, Ind.	Contained a boron preservative.
Libby's Salad Dressing, . .	Libby, McNeill & Libby, Chicago, Ill.	Contained a boron preservative.
"My Wife's" Salad Dressing,[1] .	My Wife's Salad Dressing Company, New York and Chicago.	Contained a boron preservative.
Yacht Club Salad Dressing, .	Tildesley & Co., Chicago, Ill.,	Contained a boron preservative.

Shellfish.

The clams and oysters examined during the past year were found to be free from preservatives; 6 out of 8 samples of shrimp contained boron preservatives; and 1 sample each of shrimp paste and lobster paste, put up by Harry Peck, London, Eng., were preserved in the same manner.

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[1] Samples from more recent lots contained no boron.

Spices.

One hundred and sixty-one samples were examined, of which 156 were pure. The adulterated brands were as follows: —

Mace, manufactured by Twicher, Champlin Company, Boston and Portland, contained a large admixture of wild mace. The Merrimac Brand of Pure White Pepper, put up by F. M. Bill, Lowell, contained 25 per cent. of peas and wheat. The Ardent Brand Pure Black Pepper, put up by W. G. Dean & Son, New York, contained 30 per cent. wheat.

Powdered Sugar.

Four samples were examined, 1 of which was found to contain 2.35 per cent. of sodium bicarbonate. This sample was sent in to the department by a woman who claimed to have purchased it in a large grocery store in Boston. Subsequently two samples were purchased in that store by one of the inspectors, and both samples were found pure.

Syrup.

Eight samples were examined, of which 2 were adulterated. These were samples of strawberry and raspberry syrup, put up by Philip J. Ritter Conserve Company, Philadelphia, Pa., and were preserved with benzoic acid.

Table Sauce.

Forty-four samples were examined, of which 11 were adulterated, containing added preservatives. The adulterated brands are given in the following table: —

Table Sauce, etc.

Brand.	Manufacturer or Wholesaler.	Results of Analyses.
"Asparox," a beverage for seasoning.	Armour & Co., Chicago, Ill., .	Preserved with salicylic acid.
"Bordeau Tomato Catsup," .	Standard Packing Company, Indianapolis, Ind.	Preserved with benzoic acid.
Libby's tomato chutney, . .	Libby, McNeill & Libby, Chicago, Ill.	Preserved with benzoic acid.
Libby's chili sauce,[1] . . .	Libby, McNeill & Libby, Chicago, Ill.	Preserved with benzoic acid.
"Old Virginia" chutney, . .	McMechen Preserving Company, Wheeling, W. Va.	Preserved with benzoic acid.
"Our Favorite Catsup,"[2] . .	Erie Preserving Company, Buffalo, N. Y.	Preserved with benzoic acid.
"The Escoffier Sauce Robert," .	Escoffier, Ltd., Ridgmont St., Tottenham Court Road	Preserved with benzoic acid.
"Picador" tomato bouillon, .	Crown Cordial and Extract Company, New York.	Preserved with benzoic acid.
Tomato bouillon, . . .	Armour & Co., Chicago, Ill., .	Preserved with salicylic acid.
Tomato bouillon, . . .	Armour & Co., Chicago, Ill., .	Preserved with salicylic acid.

[1] Guaranteed under food and drugs act, June 30, 1906.
[2] Percentage of preservative not stated on label.

Vinegar.

Forty-three samples of vinegar were examined, of which 3 were so-called white wine or distilled vinegar above the standard, 29 were cider vinegar above the standard, 5 were cider vinegar below the standard and 6 were sold as cider vinegar and were not the product of pure apple juice.

The average composition of the samples of cider vinegar and the composition of the adulterated samples of vinegar are given in the following tables: —

Cider Vinegar above Standard.

	Acetic Acid (Per Cent.).	Solids (Per Cent.).	Ash (Per Cent.).	Alkalinity of Ash.[1]	Polarization 200 mm. (Ventzke Scale).	Lead Acetate (ppt. c.c.).
Highest, . .	5.42	2.74	0.48	29.2	—4.1	1.45
Lowest, . .	4.52	2.00	0.20	24.2	—0.8	0.30
Average, . .	5.06	2.35	0.34	26.9	—2.1	0.87

Adulterated Vinegar.

Acetic Acid (Per Cent.).	Solids (Per Cent.).	Ash (Per Cent.).	Alkalinity of Ash.[1]	Polarization 200 mm. (Ventzke Scale).	Lead Acetate (ppt. c.c.).	Color.
4.94	2.27	0.09	-	2.1	0.00	Caramel.
4.80	1.54	0.14	-	—0.1	0.58	Caramel.
4.79	2.88	0.04	-	0.8	0.00	Caramel.
4.74	0.33	0.10	-	0.7	0.02	Caramel.
4.71	2.74	0.11	-	2.6	0.00	Caramel.
4.64	1.82	0.19	6.80	—0.1	0.20	Caramel.

Wine.

Fifteen samples were examined, of which 4 were adulterated. One sample each of unfermented grape wine, unfermented blackberry wine and unfermented blood orange wine, manufactured by the Los Angeles Fruit Cider Company, Los Angeles, Cal., were examined. These samples proved to be aqueous solutions of inverted cane sugar, containing a small amount of malic acid, and were artificially colored and flavored. A sample of Fruce, "The Liquor of Fruit," manufactured by the Fruce Company, North Attleborough, was examined. This was sent in by a no-license league, with the complaint that it seemed to produce violent intoxication. This sample proved to be a very highly fortified wine, containing 33.97 per cent. of alcohol, which no doubt accounted for the violent intoxication.

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[1] Determined as described on p. 368.

Yeast.

Four samples of yeast were examined, 3 of which are reported adulterated by reason of their containing a large admixture of wheat starch. One sample was found free from starch, a sample of Fleischmann's Compressed Yeast contained 20.50 per cent. starch, one of Old Colony Compressed Yeast contained 18.88 per cent. starch and one of Bay State Compressed Yeast contained 12.96 per cent. of starch.

Examination of Food for Preservatives.

In examining ketchup, jams, jellies and other food products of similar consistency for the presence of benzoic and salicylic acids by the usual methods, there is great difficulty in making the ether extraction, and it has been found impossible in some cases to extract benzoic acid from these foods when its presence has been known. This is no doubt due to the mechanical difficulty of mixing the solvent with the solution; and in order to avoid this trouble, and also to prevent undesirable coloring matter from getting into the final solution before testing, the following method was devised and has been used with success: —

Place 50 to 100 grams of the sample in 500 cubic centimeters Kjeldahl distilling flask, make acid with phosphoric acid and distil with steam until the distillate measures 300 cubic centimeters. Filter the distillate, make slightly alkaline with sodium carbonate and evaporate to a volume of about 25 or 50 cubic centimeters. Acidify this solution with dilute hydrochloric acid, extract with ether, wash the ether extract two or three times with water, extract with ammonia, evaporate the ammonia until the solution is neutral, and add a few drops of a slightly acid 10 per cent. ferric chloride solution. If salicylic acid is present, the characteristic violet coloring will be produced, and a flesh-colored precipitate will be obtained when benzoic acid is present. This is sufficient to identify either preservative. If, however, it is desired to go further, the precipitate, if benzoic acid is present, is transferred to a platinum dish, dried and sublimed, the sublimate being collected on a watch glass. Crystals of benzoic acid are obtained which are very characteristic in appearance and odor. The sublimate may then be treated with ammonia, and, after evaporating until neutral, a few drops of ferric chloride or copper sulphate solution added to get a precipitate of the flesh-colored iron salt or blue-colored copper salt.

If salicylic acid is present, the violet solution may be made acid, extracted with ether, the ether washed with water, extracted with ammonia, the ammonia evaporated and a few drops of copper sulphate added. This solution, filtered if necessary, will be of a peculiar intense green color if salicylic acid is present.

Boron and sulphites are tested for as described in former reports.

Summary of Statistics of Food, exclusive of Milk.

CHARACTER OF FOOD.	Genuine.	Adulterated.	Total.
Asparox,	0	1	1
Apples,	1	0	1
Baking powder,	8	2	10
Butter,	83	4	87
Canned fruits and vegetables,	24	4	28
Cheese,	15	0	15
Chopped nuts,	1	0	1
Cider,	21	24	45
Cocoa,	33	6	39
Coffee,	21	0	21
Condensed milk,	12	7	19
Confectionery,	4	0	4
Cream,	26	0	26
Cream of tartar,	52	0	52
Diabetic flour,	2	1	3
Eggs,	1	0	1
Flavoring extracts: —			
Almond,	3	0	3
Cinnamon,	2	0	2
Lemon,	9	6	15
Orange,	0	1	1
Peppermint,	1	0	1
Strawberry,	0	1	1
Vanilla,	35	12	47
Wintergreen,	1	1	2
Fruit juices: —			
Grape juice,	11	4	15
Lime juice,	0	2	2
Red currant juice,	1	0	1
Honey,	29	0	29
Horseradish,	8	1	9
Jams and jellies,	58	12	70
Lard,	6	0	6
Malt liquors: —			
Ale,	14	0	14
Beer,	6	0	6
Malt extract,	9	0	9
Porter,	12	1	13
Maple sugar,	38	28	66
Maple syrup,	39	35	74
Meat products: —			
Beef extract,	3	1	4
Canned meats,	27	9	36
Corned beef,	1	0	1
Hamburg steak,	28	17	45
Hogshead cheese,	33	0	33
Jellied meats,	2	0	2
Lambs' tongues,	5	0	5
Mince meat,	23	12	35
Pickled tongue,	1	0	1
Pigs' feet,	1	0	1
Pressed corned beef,	1	0	1
Sausages,	168	10	178
Tongue cheese,	1	0	1
Tripe,	9	0	9
Molasses,	5	0	5
Non-alcoholic drinks,	23	0	23
Olives,	4	0	4
Pastry,	3	1	4
Peanut butter,	5	0	5
Pickles,	108	61	169
Proprietary foods,	1	0	1
Salad dressing,	26	7	33
Saleratus,	5	0	5

Summary of Statistics of Food, etc.—Concluded.

Character of Food.	Genuine.	Adulterated.	Total.
Shellfish, etc.:—			
Clams,	4	0	4
Clam bouillon,	1	0	1
Lobster paste,	0	1	1
Oysters,	9	0	9
Shrimps,	2	6	8
Shrimp paste,	0	1	1
Spices,	156	5	161
Sugar,	3	1	4
Syrup,	6	2	8
Table sauce,	33	11	44
Tea,	3	0	3
Turkeys,	2	0	2
Vinegar,	32	11	43
Wine,	11	4	15
Yeast,	1	3	4
Total,	1,332	316	1,648

DRUGS.

The character and quality of the drugs examined are shown in the table on page 385. Comment will be made on individual drugs only when necessary. There has been a notable improvement in the quality of the drugs sold during the past year, principally in the cases of beeswax, olive oil, tincture of iodine and extract of witch hazel.

Alcohol.

Fifty-nine samples were collected, of which 21 were watered. These samples varied in strength from 45 to 85 per cent. alcohol by volume.

Aqua Hamamelidis Spirituosa.

One sample of witch hazel extract out of the 42 examined was classed as adulterated, as it contained formaldehyde. All the samples examined during the year were free from wood alcohol. This is a great improvement over the conditions of last year, when nearly 10 per cent. of the samples examined were adulterated, and 2 of them contained wood alcohol.

Extractum Glycyrrhizæ.

Five samples were examined, all of which were adulterated with wheat starch.

Fluid Extractum Zingiberis.

Fifteen samples were examined, 7 of which were made with weak alcohol, and consequently contained but little ginger oil and resin.

Linimentum Camphoræ.

The price of camphor has increased considerably since the Japanese-Russian war, and consequently the amount of camphor in standard pharmaceutical preparations has decreased. During the past year the attention of the department has been directed towards the composition of the camphorated oil on the market, and in a large number of cases the samples have been found rather low in camphor.

Camphorated oil or camphor liniment is prepared according to the dispensatory and the Pharmacopœia as follows: "Camphor in coarse powder, 200 grams; cotton-seed oil, 800 grams, to make 100 grams. Introduce the camphor and cotton-seed oil into a suitable flask and apply gentle heat, by means of a water bath, loosely stoppering the flask during the operation. Agitate from time to time during the operation." When prepared in this manner, camphorated oil will contain 20 per cent. of camphor.

For the purpose of finding the constants of the standard article, several samples of camphorated oil were made as described above, using different samples of camphor. The polariscope, a Schmidt and Haensch saccharimeter, was found to be the best means of examination, the sample being polarized in a 100-millimeter tube, using a color screen consisting of a 50-millimeter tube containing a 10 per cent. solution of potassium bichromate, to correct for the dispersion of the camphor. From the examination of full-strength and weak camphorated oils the following table has been prepared, showing the percentage of camphor corresponding to the polarization of the sample: —

Camphorated Oil.

Polarization, 100 mm. (Ventzke Scale).	Camphor (Per Cent.).	Polarization, 100 mm. (Ventzke Scale).	Camphor (Per Cent.).	Polarization, 100 mm. (Ventzke Scale).	Camphor (Per Cent.).
—0.3	0	9.7	7	19.7	14
1.1	1	11.2	8	21.1	15
2.6	2	12.6	9	22.6	16
4.0	3	14.0	10	24.1	17
5.4	4	15.5	11	25.7	18
6.9	5	16.9	12	27.2	19
8.3	6	18.3	13	28.7	20

The following table contains the names of dealers from whom weak camphorated oil has been obtained, together with the percentage of camphor in each sample: —

List of Adulterated Samples of Camphorated Oil.

Dealer.	Per Cent. of Camphor in Sample.	Dealer.	Per Cent. of Camphor in Sample.
E. E. Gray, Boston,	1	Dr. C. Henotte, Lowell,	10
J. H. Folkins Company, Chelsea,	2	Charles Crompton, Lynn,	13
Proctor's Pharmacy, Dorchester,	3	E. H. Patten, Cambridge,	14
Edwin V. Blanchard, Worcester,	4	Sanders Pharmacy, Cambridge,	14
C. H. & H. A. Lawton, New Bedford,	8	A. P. Parkhurst, Gloucester,	14
S. G. Leyford Company, Lowell,	8	M. W. Perkins, Gloucester,	15
Gowing Extract Company, Reading,	10	S. N. Farwell, Cambridge,	16

Oleum Olivæ.

Only one poor sample of olive oil was found, out of 120 samples collected and examined during the year. This record of purity is extraordinary, and is the first time it has occurred in the history of the department. The one adulterated sample contained 80 per cent. of cotton-seed oil. The ratio of adulteration of olive oil for the past nine years is as follows: —

Year.	Percentage of Adulteration.	Year.	Percentage of Adulteration.
1907,	.8	1903,	31.0
1906,	13.3	1902,	29.5
1905,	7.0	1901,	27.6
1904,	28.8	1899,	26.0

The percentage of adulteration, as seen from this, was fairly constant at about 29 per cent. until 1904, when the olive oil as sold by druggists began to get purer.

Proprietary Medicines.

One hundred and seventy-five proprietary medicines were examined, 91 of which were classed as adulterated. Most of these medicines were examined for cocaine, and the following list gives the names of the preparations in which cocaine was found. In detecting cocaine in coca wine the following method was employed: evaporate 200 cubic centimeters to a syrupy consistency, add 200 cubic centimeters alcohol, allow the precipitate to subside, and filter. Evaporate the alcohol from the filtrate, dilute if necessary (depending upon the consistency of the solution), make alkaline with ammonia and extract with benzol. Evaporate the combined benzol extracts to a small volume at a low temperature, and allow the final evaporation to take place spontaneously on a watch glass. The resulting deposit is sometimes amorphous and sometimes crystalline; in the latter case a great play of colors is shown when viewed under the microscope with polarized light. The residue may then be dissolved in a little diluted hydrochloric acid, and the solution will show the characteristic alkaloidal and physiological reactions for cocaine. If the residue is not crystalline, dissolve in diluted acid, filter, extract the filtrate with benzol, make alkaline and extract as described above, and the alkaloid is usually sufficiently pure to crystallize.

Preparations containing Cocaine.

Name of Drug.	Manufacturer or Wholesaler.
Anglo-American Catarrh Powder, . .	Anglo-American Catarrh Powder Company, Chicago Ill.
Coca Wine, ...	A. W. Dows & Co., Lowell.
Coca Wine, ...	Charles H. Dexter, Boston.
Coca Wine, ...	Cushing Medical Supply Company, Boston.
Coca Wine, ...	Davies, Rose & Co., Boston.
Coca Wine, ...	Eastern Drug Company, Boston.
Coca Wine, ...	E. F. Mattison, Providence, R. I.
Coca Wine, ...	Kingston Chemical Company, Boston.
Coca Wine, ...	Lewis The Manufacturing Chemist, Boston.
Coca Wine, ...	Maverick Drug Company, East Boston.
Coca Wine, ...	New York and Boston Drug Company, New York.
Coca Wine, ...	Ropes Drug Company, Salem.
Coca Wine, ...	Stewart & Salisbury, Charlestown and Somerville.
Coca Wine, ...	W. B. Markell's Drug Stores, Chelsea and Boston.
Coca Wine, ...	Wm. H. Knight, Boston.
Crown Catarrh Powder, ...	Crown Catarrh Powder Company, New York.
Dr. Birney's Catarrhal Powder, . .	Birney Catarrhal Powder Company, Chicago, Ill.
Dr. Cole's Catarrh Cure, ...	The Cole Medicine Company, London, N. Y.
Epstein's Coca Wine, ...	Epstein Cut Price Drug Stores, Boston.
Gem Catarrh Powder, ...	Gem Medicine Company, Boston.
Green's Coca Wine, ...	Green The Druggist, Worcester and Springfield.
I. C. R. Instant Catarrh Relief, . .	I. C. R. Medicine Company, Boston.
Kola Cardinette, ...	Palisade Manufacturing Company, Yonkers, N. Y.
Maltine with Coca Wine, ...	Maltine Manufacturing Company, New York.
Metcalf's Coca Wine, ...	Theodore Metcalf Company, Boston.
Opal Catarrh Powder, ...	Standard Remedy Company, Boston.
Quina Laroche, ...	The American Branch of P. Comar & Son & Co. (of Paris), New York.
Standard Catarrh Powder, ...	Standard Catarrh Powder Company, Boston.
The Miles Mixture for Catarrh, . .	Miles Medicine Company, Boston.
Vin Mariani a la Coca du Pérou, . .	- - - - -

The following headache powders and cold cures were found to contain acetanilid: Az-Ma-Syde, Emerson's Bromo-Seltzer, Celero Headache Lozenge, Hill's Cascara Bromide Lozenge, Quimby's Headache Powder, Wilcox's Headache Powder, Shac, Dr. Holbrook's Kola Powders, and Week's Break up a Cold Tablets.

Dr. Carney's Common-sense Cure for the Opium Habit.

The price of this cure was from $10 to $15 per month, and the medicine was dispensed in 30 small bottles, numbered from 1 to 30 inclusive, and a large bottle, marked "Emergency." The patient was directed to take the contents of one small bottle per day in the order of their numbers, and if necessary to use some from the emergency bottle. If the contents of any one bottle was not used up in a day, the rest was to be thrown away and not carried over until the next day. The samples in each of the four treatments examined were found to be identical, the liquid in each case containing respectively 2, 3, 8 and 9 grains of morphine per fluid ounce. The cure apparently consisted in letting the patient have all the morphine he desired, thus satisfying his appetite. This medicine is not on the market at present.

Sodii Boras.

Three samples were examined, one of which, Black Diamond Borax, consisted of sodium bicarbonate 60 per cent., borax 40 per cent. This sample was manufactured by Archibald & Lewis, 93 Flint Street, New York.

Spiritus Camphoræ.

Thirty-one of the 215 samples examined were low in camphor. The high price of camphor has no doubt considerable to do with this rate of adulteration, as in the case of camphorated oil. The samples were examined by means of the polariscope and the Abbe refractometer, as described in the 1905 report, page 513. The amount of camphor in the spirit of camphor examined is shown by the following table. The standard required by the Pharmacopœia is 100 grams per liter.

1	sample	containing	2.5	grams	camphor	per	liter.
1	"	"	35	"	"	"	"
2	samples	"	40 to 50	"	"	"	"
2	"	"	50 to 60	"	"	"	"
4	"	"	60 to 70	"	"	"	"
7	"	"	70 to 80	"	"	"	"
6	"	"	80 to 90	"	"	"	"
8	"	"	90 to 95	"	"	"	"

It will be seen from the above table that the samples of spirit of camphor on the market are not nearly so bad as those of camphorated oil. This is no doubt due to the prosecutions of previous years.

Spiritus Frumenti.

The 6 adulterated samples of whiskey consist largely of diluted and colored alcohol artificially flavored. One sample of Russian Vodka, also labelled Corn Shnaps, and Pure Rye Whiskey, was sent in, the purchaser saying that it was productive of terrible "heads." This sample was found to contain 62 per cent. of alcohol by volume.

Spiritus Menthæ Piperitæ.

Five out of 8 samples were low in peppermint oil. The method employed for determining peppermint oil in essence of peppermint is as follows: place 10 cubic centimeters essence of peppermint in a Babcock milk bottle, add water with occasional shaking until the bottle is filled, whirl in the centrifuge for a few minutes and read the volume of oil as usual. It has been found that about 5 per cent. of the oil present remains in solution; therefore the formula $\frac{\text{oil reading} \times 2}{0.95}$ gives the percentage of oil in the sample.

Tinctura Iodi.

Of 232 samples, 47 were poor, owing to a deficiency of iodine. This is a much lower ratio of adulteration than was found last year, and but 20 of the samples were below 85 per cent. of the U. S. P. strength, while the average tincture was well over 94 per cent. of the required strength. This improvement shows that a few prosecutions have convinced the drug trade of not only the possibility but also the advisability of making their tinctures up to strength. One sample was found to contain wood alcohol. This was sent in by a woman, who wrote that both she and her boy were nearly blinded by it; that she stated this fact to the druggist, who told her the tincture was all right. Naturally, the tincture subsequently purchased by our inspector at the same store was good, and, as we were unable to locate the woman, the druggist could not be prosecuted.

Tinctura Zingiberis.

Nine samples were examined, of which 3 were adulterated, having been made with weak alcohol.

Summary of Drug Statistics.

	Genuine.	Adulterated.	Total.
Æther, ...	1	0	1
Alcohol, ...	38	21	59
Aqua ammoniæ fortior, . .	1	0	1
Aqua hamamelidis spirituosa, .	41	1	42
Calx chlorinata, ...	2	0	2
Cera alba, ...	1	0	1
Cera flava, ...	10	2	12
Cigarettes, ...	3	0	3
Extractum glycyrrhizæ, . .	0	5	5
Ferri et quininæ citras, . .	1	0	1
Fluid extractum zingiberis, .	8	7	15
Glycerinum, ...	54	1	55
Linimentum camphoræ, . .	19	14	33
Liquor calcis, ...	1	1	2
Magnesii sulphas, ...	1	0	1
Oleum cinnamomi, ...	1	0	1
Oleum limonis, ...	3	0	3
Oleum morrhuæ, ...	7	0	7
Oleum olivæ, ...	119	1	120
Oleum ricini, ...	10	0	10
Oleum throbromatis, . .	1	0	1
Proprietary medicines, . .	84	91	175
Sodii boras, ...	2	1	3
Sodii phosphas, ...	11	0	11
Sodii phosphas effervescens, .	1	0	1
Spiritus camphoræ, ...	184	31	215
Spiritus frumenti, ...	1	6	7
Spiritus menthæ piperitæ, .	3	5	8
Spiritus myrciæ, ...	2	0	2
Spiritus vini gallici, ...	0	1	1
Tinctura iodi, ...	190	47	237
Tinctura zingiberis, ...	6	3	9
Total, ...	806	238	1,044

General Summary.

	Genuine.	Adulterated.	Total.
Milk, ...	2,000	992	2,992
Foods exclusive of milk, ...	1,332	316	1,648
Drugs, ...	806	238	1,044
Total, ...	4,138	1,546	5,684

INSPECTION OF LIQUORS.

One hundred and forty-six samples of liquor have been sent in by the police departments of 23 cities and towns; 90 of these samples contained more than 1 per cent. of alcohol, and 50 samples contained less than 1 per cent. of alcohol. The following table gives the number and character of the samples obtained from the different localities: —

Summary of Liquor Statistics.

Cities and Towns.	Number of Samples of Wine.	Number of Samples of Cider.	Number of Samples of Beer.	Number of Samples of Whiskey.	Number and Character of Miscellaneous Samples.
Athol,	–	–	42	–	
Boston,	–	1	2	1	3, Arak.
Cambridge,	3	1	–	–	3, malt extract; 1, Jamaica ginger.
Danvers,	–	1	–	–	1, Beerine.
Fall River,	–	–	–	5	
Framingham,	–	–	4	–	
Franklin,	3	4	8	–	
Foxborough,	–	5	–	–	
Gardner,	–	–	1	–	
Holliston,	–	–	1	–	
Hyde Park,	–	2	–	–	
Lexington,	–	3	–	–	3, Mazzo.
Maynard,	–	2	–	–	
Melrose,	–	4	–	–	
Middleborough,	–	–	2	–	
Plainville,	–	–	–	–	1, Fruce.
Randolph,	–	–	–	2	
Revere,	–	1	3	1	
Salem,	–	10	4	–	1, Elixir St. Michel.
Townsend,	–	–	–	–	1, Jamaica ginger; 1, malt extract.
Waltham,	–	9	–	–	
Westborough,	–	–	–	–	3, mixtures.
Winthrop,	–	3	–	–	
Totals,	6	46	66	9	19

Samples of malt extract contained from 4.5 to 7 per cent. alcohol; the Jamaica ginger extracts contained from 10 to 71 per cent. alcohol; the samples of whiskey contained from 28 to 48 per cent. alcohol; 3 samples of Arrack contained respectively 48.96, 49.07 and 54.95 per cent. alcohol; the Elixir St. Michel contained 17.17 per cent. of alcohol; the Westborough mixtures consisted of rum and tea, and contained about 49 per cent. of alcohol.

The attendance of the analyst has been required in the lower courts at Boston, East Boston, Malden, Salem, Walpole, Waltham, and in the superior courts of Essex and Suffolk counties.

Respectfully submitted,

HERMANN C. LYTHGOE.

INSPECTION OF DAIRIES.

By the Secretary of the Board.

INSPECTION OF DAIRIES.

During the year ended Nov. 30, 1907, 2,714 dairies were examined by the Board's veterinarian, and the attention of 1,805 proprietors and of boards of health of cities and towns, wherein the dairies were situated or the product thereof sold, was called to a total of 7,243 objectionable conditions. As in former years, suggestions were made as to changes regarded as necessary in the interest of a wholesome supply and of the public health.

Of the total number of dairies examined, 2,054 were situated in Massachusetts and 660 in neighboring States. The extrastate dairies were visited because of the fact that their product is marketed in this Commonwealth, and, if found to be other than the fresh, clean product of healthy cows, is, under the standards fixed in accordance with the provisions of the national law relative to food and drugs, to be deemed to be adulterated, and hence may not enter into interstate commerce. The attention of the national authorities was called to the fact that a not inconsiderable portion of the milk sent into local markets from these dairies was stale and dirty, and from diseased cows; but the request that it be excluded from interstate commerce was unproductive of results.

The following table shows the number of dairies examined in the cities and towns visited, and the percentage found in each place to be commendable or objectionable: —

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Acushnet,	67	55	12	17.91
Attleborough,	66	40	26	39.39
Avon,	18	9	9	50.00
Berkley,	24	12	12	50.00
Blackstone,	39	30	9	23.08
Braintree,	21	12	9	42.86
Brimfield,	21	10	11	52.38

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Brookfield,	28	11	17	60.71
Cambridge,	9	4	5	55.56
Canton,	22	9	13	59.09
Charlton,	52	47	5	9.62
Chicopee,	35	19	16	45.71
Cohasset,	11	5	6	54.55
Dartmouth,	197	161	36	18.27
Dedham,	42	21	21	50.00
Dighton,	9	5	4	44.44
Dover,	26	17	9	34.62
Dudley,	21	16	5	23.81
Easton,	38	21	17	44.74
Fairhaven,	48	43	5	10.42
Fall River,	74	53	21	28.38
Foxborough,	25	13	12	48.00
Freetown,	17	16	1	5.88
Granby,	74	65	9	12.16
Halifax,	16	7	9	56.25
Hingham,	14	6	8	57.14
Holbrook,	11	3	8	72.73
Mansfield,	27	10	17	62.96
Mattapoisett,	15	13	2	13.33
Milton,	29	20	9	31.03
Needham,	24	17	7	29.17
New Bedford,	61	52	9	14.75
North Attleborough,	20	14	6	30.00
Northbridge,	25	23	2	8.00
North Brookfield,	32	12	20	62.50
Norton,	20	12	8	40.00
Oakham,	35	25	10	28.57
Plainville,	16	6	10	62.50
Quincy,	37	24	13	35.14
Randolph,	20	13	7	35.00
Raynham,	21	11	10	47.62
Scituate,	15	4	11	73.33
Seekonk,	21	13	8	38.10
Sharon,	9	2	7	77.78
Somerset,	42	34	8	19.05

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Somerville, ...	10	7	3	30.00
Spencer, ...	50	44	6	12.00
Stoughton, ...	22	11	11	50.00
Swansea, ...	69	39	30	43.48
Taunton, ...	64	29	35	54.69
Uxbridge, ...	43	28	15	34.88
Warren, ...	57	24	33	57.89
West Brookfield, ...	31	8	23	74.19
Westport, ...	80	65	15	18.75
Westwood, ...	27	12	15	55.56
Weymouth, ...	30	17	13	43.33
Miscellaneous, ...	77	51	26	33.77
Ashford, Conn., ...	6	5	1	16.67
Brooklyn, Conn., ...	4	4	-	-
Chaplin, Conn., ...	17	14	3	17.65
Columbia, Conn., ...	6	4	2	33.33
Coventry, Conn., ...	12	9	3	25.00
Eastford, Conn., ...	10	7	3	30.00
Hampton, Conn., ...	21	18	3	14.29
Lebanon, Conn., ...	2	2	-	-
Mansfield, Conn., ...	10	7	3	30.00
Pomfret, Conn., ...	21	16	5	23.81
Scotland, Conn., ...	3	3	-	-
Willimantic, Conn., ...	1	1	-	-
Windham, Conn., ...	5	4	1	20.00
Buxton, Me., ...	5	5	-	-
Gorham, Me., ...	30	26	4	13.33
North Berwick, Me., ...	36	23	13	36.11
Wells, Me., ...	4	1	3	75.00
Westbrook, Me., ...	1	1	-	-
Antrim, N. H., ...	21	10	11	52.38
Bennington, N. H., ...	3	-	3	100.00
Chester, N. H., ...	1	1	-	-
Deering, N. H., ...	6	2	4	66.67
Derry, N. H., ...	14	10	4	28.57
Francestown, N. H., ...	4	4	-	-
Greenfield, N. H., ...	31	23	8	25.81
Hancock, N. H., ...	29	20	9	31.03

CITY OR TOWN.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Hillsborough, N. H.,	20	10	10	50.00
Hudson, N. H.,	9	7	2	22.22
Jaffrey, N. H.,	9	6	3	33.33
Londonderry, N. H.,	21	16	5	23.81
Pelham, N. H.,	1	1	-	-
Peterboro, N. H.,	23	15	8	34.78
Sharon, N. H.,	1	-	1	100.00
Windham, N. H.,	7	5	2	28.57
Buskirks, N. Y.,	26	13	13	50.00
Cambridge, N. Y.,	23	11	12	52.17
Eagle Bridge, N. Y.,	23	19	4	17.39
Hoosick, N. Y.,	5	5	-	-
Petersburg, N. Y.,	2	1	1	50.00
Schaghticoke, N. Y.,	18	11	7	38.89
Burrillville, R. I.,	1	1	-	-
Little Compton, R. I.,	37	18	19	51.35
Portsmouth, R. I.,	5	2	3	60.00
Tiverton, R. I.,	41	30	11	26.83
Barnet, Vt.,	6	5	1	16.67
Barton, Vt.,	8	6	2	25.00
Brownington, Vt.,	1	1	-	-
Burke, Vt.,	6	4	2	33.33
Coventry, Vt.,	7	4	3	42.86
Irasburg, Vt.,	1	1	-	-
Lyndon, Vt.,	6	6	-	-
Lyndonville, Vt.,	8	6	2	25.00
McIndoes, Vt.,	1	1	-	-
Newark, Vt.,	1	1	-	-
Newport, Vt.,	1	-	1	100.00
Putney, Vt.,	14	8	6	42.86
St. Johnsbury, Vt.,	5	4	1	20.00
Sutton, Vt.,	11	10	1	9.09
Westminster, Vt.,	9	7	2	22.22
Outside dairies,	660	455	205	31.06
Total Massachusetts dairies,	2,054	1,350	704	34.27
Total dairies,	2,714	1,805	909	33.49

Under "Miscellaneous" are included dairies situated in the following towns, in no one of which were more than 8 inspected, the examinations having been made for some special reason, and not as a part of a general investigation: —

Beverly.
Brookline.
Carlisle.
Concord.
Douglas.
Grafton.
Hanson.
Hyde Park.
Lakeville.
Ludlow.
Monson.
Natick.
New Braintree.
Norfolk.
Rehoboth.
Rochester.
Southborough.
Walpole.
Watertown.
Webster.
Woburn.
Wrentham.

As shown in the above table, the percentage of Massachusetts dairies free from objectionable features was 34.27 and of extrastate dairies, 31.06; and of all, 33.49. These figures indicate a substantial improvement in general conditions observed on first inspection.

Concerning the conditions observed in other States, the following facts are presented: —

New Hampshire Dairies.

Total number of New Hampshire dairies examined,	200
Number found to be free from objectionable conditions,	70
Number to which letters were sent,	130
Total number of conditions to which attention was called,	604
Percentage of dairies which passed inspection,	35

The milk produced on these farms is collected by three different contractors, who may be designated "A," "B" and "C." The sanitary condition of the barns in contractor "A's" territory was commonly found to be far from commendable; many of the cows were exceedingly filthy and not a few of them showed evidence of tubercular disease of the udder as well as of the lungs.

The farms which supplied contractor "B" were observed to be in a far more cleanly condition than those supplying "A," but some of them were found to be very dirty, unventilated and undrained. Some of them have proper milk houses or milk rooms, and most of them have "coolers" and use ice. Numbers of the cows were observed to have tuberculosis either of the lungs or of the udder, and many of them were very filthy.

The milk bought by contractor "C" was found to be collected every other day, and hence was in part, at least, forty-eight hours old before leaving the barns. It was said that the producers themselves would prefer to ship their milk daily, but that the contractor was unwilling to run the car any oftener. Inasmuch as the milk on arrival at its destination is not immediately sold, but commonly is held upwards of twenty-four hours, it is clear that this milk must be about three days old before delivery to the consumer.

The barns in contractor "C's" territory were very generally dirty, poorly ventilated and badly drained. Very few of them have milk rooms, and in most cases the milk is cooled and stored in troughs in the barn. Many of the cows show evidences of tuberculosis either of the lungs or of the udder, or both.

Inquiry among the farmers developed the fact that contractor "B" has made an earnest effort to enforce cleanliness and proper storage of milk; that contractor "A" appears to have been less urgent in this particular; and that contractor "C" does absolutely nothing to promote cleanliness at the place of production or to consider the interests of the producers.

Vermont Dairies.

Eighty-five farms, sending milk into Massachusetts, situated in the following 14 towns, — Barnet, Barton, Brownington, Burke, Coventry, Irasburg, Lyndon, McIndoes, Newark, Newport, Putney, St. Johnsbury, Sutton and Westminster, — were visited. In this territory the great majority of the barns are supplied with running water conducted through pipes from springs situated at a distance of from 300 feet to a half mile. Of the 85 places visited, 78 were thus supplied, and 7 relied upon wells.

On but few of these farms was there a milk house or milk room. The milk is strained, as a rule, back of or otherwise near the cows, and cooled in a trough of running water in the barn or cow yard. The trough is commonly used also as a watering place for cows, horses and other animals. In some instances the trough is placed at the roadside, and serves as a public watering place.

The milk car which conveys the product of these farms to Boston takes it on at the several stations, within two hours after the morning milking, so that, circumstanced as this district is in the matter of running water, the milk house or milk room is not of the importance which it has ordinarily.

The 1,167 cows on these 85 farms furnish to the Boston market nearly 7,000 quarts of milk daily. In point of general health, their average is very high. Not all of them were examined individually, but of the large number that were examined not one showed any evidence of disease, and not an indurated udder was observed.

Of the 85 farms, 20, or nearly one-fourth, were reported as generally commendable; and 65 showed a total of 221 objectionable conditions, chiefly uncleanliness of tie-ups, lack of light and dirty condition of cows.

New York Dairies.

In the 6 towns of Buskirks, Cambridge, Eagle Bridge, Hoosick, Petersburg and Schaghticoke, 97 milk farms were visited. The total number of cows kept was 859, and the amount of milk sent into Massachusetts therefrom was about 4,600 quarts daily. The cows are not housed in summer, but are kept at pasture all the time, and are milked out of doors. Being pastured at considerable distances from the barns, and scattered, it was impossible to examine them to any great extent. Milk houses and milk rooms appear to be unknown, and the milk is cooled, handled and stored in all sorts of places, — good and bad.

Of the 97 barns visited, 37 may be rated as "fair," 18 were found to be extremely dirty, 40 were less dirty, and 2 were absolutely unfit and beyond the possibility of being made fit for milk production.

What the winter conditions may be, when the cows are confined, can only be surmised.

Maine Dairies.

In the towns of Buxton, Gorham, North Berwick and Westbrook, 76 sources of the Massachusetts milk supply were visited. The aggregate number of cows kept was 877, and the daily shipment of milk about 5,200 quarts.

These dairies are distinctly inferior in all respects to those of any other equal area visited. While one-fourth of them may be rated as somewhat below "fair," about an equal number were reported as extremely dirty, the condition of some of them being beyond the power of description, both as to cows and premises; and about one-half were dirty or otherwise objectionable to a lesser extent. At 6 of them gross pollution of the water supply was evident on inspection.

Milk houses and milk rooms appear to be unknown, and the milk is stored in many or most cases in objectionable places and under objectionable conditions.

A number of diseased cows were noted, but the usual assertion was made that their milk was not being marketed.

Rhode Island Dairies.

In the towns of Burrillville, Little Compton, Portsmouth and Tiverton, 84 dairies were examined. The aggregate number of cows was 769, and the amount of milk shipped was slightly over 6,000 quarts daily.

The number of dairies which merited commendation was 33, or 40 per cent., which is a very good showing. Of the whole number examined, only 9 could be classed as very dirty. There were 10 dairies which were objectionable in only one particular, which could be easily remedied.

A sample of milk taken from one of the very dirty dairies showed 5,000,000 bacteria per cubic centimeter.

CONNECTICUT DAIRIES.

In addition to the 154 dairies inspected in the towns of East Granby, Enfield, Somers, Somersville, Suffield and West Stafford, when the sources of Springfield's milk supply were examined in the summer of 1906, 118, situated in the towns of Ashford, Brooklyn, Chaplin, Columbia, Coventry, Eastford, Hampton, Lebanon, Mansfield, Pomfret, Scotland, Willimantic and Windham, were visited in October of the present year. Of the former, but 16, or 10.4 per cent., were worthy of commendation; but the latter make a better, though poor, showing, there being 24, or 20.3 per cent., ratable as "fair." A number were reported as being so very dirty that only by dint of much work and extensive alterations can they be made to be even fairly suitable for milk production; 14 were reported as absolutely unfit, and beyond the possibility of improvement short of burning; and 65 as needing an aggregate of 266 suggestions for improvement of conditions. The number of cows kept at these 118 places was 1,344, and the amount of milk shipped daily was about 7,500 quarts.

In most instances the cows were at pasture, and could not be examined.

Of the several States visited, only Vermont and Rhode Island showed dairy farms comparable as a class with those of most sections of Massachusetts.

NATURE OF THE DEFECTS TO WHICH ATTENTION WAS CALLED.

Below is presented an analysis of the 7,243 objectionable conditions to which the attention of proprietors and boards of health was called: —

CONDITION OF COWS.

	Defects.	
Herds with tuberculosis,	13	
Herds with tubercular mammitis,	1	
Herds with mammitis,	7	
Herds with muco-purulent discharge,	2	
Unclean herds,	382	
Swill used as feed,	1	
		406

CONDITION OF BARNS.

Dairy unfit for milk production,	7	
Building unfit for cows,	16	
		23

Light.

Insufficient number of windows,	339	
Windows inadequate in size,	180	
		519

Ventilation.

	Defects.	
Additional ventilation needed,	24	
Barn overcrowded,	125	
		149

General Cleanliness.

General uncleanliness of premises,	941	
Tie-up in need of cleaning and whitewashing,	1,424	
Accumulated manure,	172	
Manure piled back of cows,	21	
Pools of liquid manure in depressions of floor,	4	
Horse manure on barn floor,	5	
Horse manure used as bedding for cows,	14	
Caked manure on floor and walls,	20	
Cobwebs,	17	
Privy in barn,	34	
Floor back of cows used as a privy,	3	
Trough behind cows used as a privy,	1	
Slaughtering in barn,	12	
Lack of proper drainage,	58	
Unclean cellar,	15	
Tie-up floor in need of repairing,	24	
Tie-up in need of new floor,	10	
Horses not separated from cows,	164	
Pigs kept near cows,	236	
Swill kept near cows,	44	
Storage of brewers' grains,	64	
Hay kept in tie-up,	15	
Poultry in tie-up,	11	
Poultry killed back of cows,	1	
Hencoop near tie-up,	1	
Sheep in tie-up,	1	
Goat in tie-up,	1	
Tie-up used for general storage,	1	
Dead fowls in barn cellar,	1	
Decomposing carcass of a cat in barn,	3	
Rags, iron and other junk in barn,	1	
Decomposing fruit and vegetables in barn,	2	
Carcass, hide and other remains of a cow on barn floor,	5	
		3,326

CONDITION OF COW YARDS.

Yard in need of proper drainage,	477	
General uncleanliness,	125	
Pools of stagnant water in yard,	4	
Dead fowls lying about yard,	2	
		608

WATER SUPPLIES.

	Defects.	
Well exposed to surface drainage,	62	
New well needed,	3	
		65

MILK ROOMS.

Milk room needed,	442	
Unclean milk room,	73	
Milk room unused,	46	
Milk room used for smoking,	1	
Milk room used as dog kennel,	1	
Milk room used as hencoop,	1	
Milk room used for general storage,	3	
Milk room used as laundry,	4	
Milk room in horse barn,	1	
Milk room floor in need of repairing,	1	
		573

CARE OF MILK AND MILK UTENSILS.

Milk strained in barn,		787
Milk cooled: —		
(*a*) In tub on barn floor,	1	
(*b*) In house cellar,	5	
(*c*) In hencoop,	1	
(*d*) In wagon shed,	2	
(*e*) In barn cellar,	6	
(*f*) In unused well,	1	
(*g*) Near privy,	1	
(*h*) In trough used for watering cattle,	11	
		28
Milk handled: —		
(*a*) In house cellar,	5	
(*b*) In dirty shed,	5	
(*c*) In barn,	277	
(*d*) Back of horses,	1	
(*e*) Back of cows,	7	
(*f*) In woodshed,	1	
(*g*) In dirty kitchen,	3	
		299
Milk stored: —		
(*a*) In house cellar,	5	
(*b*) In trough used for watering cattle,	11	
(*c*) In carriage house,	1	
		17
Unclean milk chest,		2
Unclean aerator,		2
Unclean refrigerator,		1
Unclean water in milk cooler,		7
Unclean faucet of milk cooler,		6

	Defects.	
Cooling tubs used for laundry purposes,	1	
Cans kept in barn,	409	
Cans kept in wagon shed,	1	
Cans inverted in rack,	1	
Cans kept near privy,	1	
Aerator kept in barn,	2	
Mixer kept in barn,	6	
Milk bottles washed in tub used for family laundry,	2	
Separator operated in dirty barn,	2	
		1,574
Total number of objectionable features,		7,243

THE INFANTILE MORTALITY OF BOSTON

DURING THE

PERIOD JUNE 1 TO NOV. 30, 1907.

By DONALD GREGG, M.D.

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On June 1, 1907, was undertaken an investigation which was to cover as completely as possible the entire infantile mortality of the city of Boston for the six months next ensuing, with especial reference to preventable causes and the influence of the mode of feeding and the character of the food. Through the courtesy of the board of health, access was granted to the daily returns of deaths, from which the necessary data as to age and place of death and other facts were derived. As soon as possible after the cases to be investigated were reported (those of infants under one year of age), the recorded residences or institutions were visited and the information desired obtained at first hand, from the mother or from the attending physician or other person having it.

During the whole period, in but four cases in which the mode of feeding could have been a factor was it impossible to obtain the required data, and then only because of removal to places unknown to neighbors. In a few cases of abandonment of infants at birth no facts were obtainable; but these cases may be disregarded so far as this investigation is concerned, inasmuch as these victims were fed neither naturally nor artificially.

In the results tabulated below, the figures do not correspond exactly with the official records, since in a number of instances incorrect ages were reported.

The number of cases reported and investigated was 1,315, divided by months as follows: —

June,	147
July,	173
August,	355
September,	277
October,	220
November,	143

These figures, when compared with available mortality statistics from other sources, are somewhat remarkable, since the fall in the number of deaths after the maximum is reached in August is commonly much more sharp, especially after September; whereas here the number is greater for September than for July, and the same is true for October, in which month the figures are usually far below those even of June; and the high rates for the months following August cannot be ascribed to unusual climatic conditions.

As to sex, the cases are fairly evenly divided, thus: —

Months.	Males.	Females.
June,	80	67
July,	91	82
August,	197	158
September,	135	142
October,	118	102
November,	70	73
	691	624

Of the total number, 29, or 2.2 per cent., were colored. A large proportion were of foreign parentage, — Italian, Russian, Polish, Irish, Bulgarian, Armenian, Greek, German, French, English, Swedish and Canadian. The largest numbers were of Italian and Irish parentage.

Concerning illegitimacy, the data are probably incomplete. So far as could be ascertained, 100, or 7.6 per cent., were of illegitimate birth. These deaths fell as follows: —

June,	8
July,	16
August,	23
September,	25
October,	21
November,	7
	100

Of twins, there were 83, or 6.3 per cent. of the whole. These cases occurred as follows: —

June,	5
July,	12
August,	22
September,	20
October,	20
November,	4
	83

Of infants boarded out, there were 25, or 1.9 per cent. These cases fell as follows: —

June,	1
August,	6
September,	7
October,	7
November,	4
	25

Geographically, by wards, the cases were distributed as in the following table: —

Distribution of Cases, by Wards.

Wards.	June.	July.	August.	September.	October.	November.	Totals.
Ward 1,	4	5	13	10	8	3	43
Ward 2,	6	8	18	15	3	4	54
Ward 3,	0	4	8	7	4	1	24
Ward 4,	2	3	9	6	4	1	25
Ward 5,	3	4	11	6	5	2	31
Ward 6,	22	25	20	20	14	13	132
Ward 7,	3	1	4	1	6	7	22
Ward 8,	8	5	7	5	6	1	32
Ward 9,	4	3	8	2	4	4	25
Ward 10,	5	0	3	1	2	1	12
Ward 11,	1	1	4	1	1	0	8
Ward 12,	0	0	2	2	8	0	12
Ward 13,	3	8	14	11	10	6	52
Ward 14,	1	5	9	8	6	4	33
Ward 15,	3	5	8	6	3	2	27
Ward 16,	2	4	3	4	4	3	20
Ward 17,	4	3	13	6	9	9	44
Ward 18,	3	1	11	5	7	7	34
Ward 19,	3	5	7	9	6	8	38
Ward 20,	3	8	12	11	10	6	50
Ward 21,	2	1	4	2	2	3	14
Ward 22,	2	0	15	5	5	3	30
Ward 23,	5	1	3	10	4	6	29
Ward 24,	7	3	13	5	4	3	35
Ward 25,	2	7	9	10	11	6	45
Totals,	98	110	228	10	149	98	851

Ward Statistics.

	Population.	Per Cent. of Foreign Born.	Persons to a Dwelling.	Annual Birth-rate per 1,000.	Number of Infant Deaths in Six Months.
Ward 1, ...	25,405	33.48	8.0	27.7	43
Ward 2, ...	25,929	44.59	11.4	27.6	54
Ward 3, ...	14,831	28.36	8.9	30.6	24
Ward 4, ...	12,499	30.06	6.7	27.8	25
Ward 5, ...	12,653	34.59	10.0	23.7	31
Ward 6, ...	29,987	61.08	20.1	50.7	132
Ward 7, ...	15,579	45.57	12.7	23.1	22
Ward 8, ...	30,810	57.17	16.1	29.6	32
Ward 9, ...	22,120	41.87	12.0	25.7	25
Ward 10, ...	23,841	28.41	10.8	11.1	12
Ward 11, ...	22,353	33.53	7.3	13.1	8
Ward 12, ...	21,738	31.39	9.2	14.5	12
Ward 13, ...	21,654	41.70	9.8	35.1	52
Ward 14, ...	22,127	31.37	8.7	26.4	33
Ward 15, ...	20,310	30.52	8.3	24.2	27
Ward 16, ...	21,924	27.93	9.0	23.1	20
Ward 17, ...	24,313	32.67	9.1	26.8	44
Ward 18, ...	22,121	32.40	9.4	26.4	34
Ward 19, ...	29,213	35.15	10.1	27.70	38
Ward 20, ...	41,805	25.93	7.4	19.7	50
Ward 21, ...	26,533	28.47	7.8	16.8	14
Ward 22, ...	27,769	33.25	8.4	24.8	30
Ward 23, ...	26,410	29.10	6.5	19.2	29
Ward 24, ...	31,650	26.74	6.6	21.2	35
Ward 25, ...	21,806	29.57	5.5	25.5	45

The occurrence of the cases in the various hospitals throughout the city is shown in the table below: —

HOSPITALS.	June.	July.	August.	September.	October.	November.	Totals.
Massachusetts General,	–	2	4	2	4	1	13
Infants',	7	Closed.			1	6	14
Lying-in,	4	0	1	6	5	3	19
Floating,	–	20	47	23	Closed.		90
Children's,	3	5	8	13	12	11	52
Boston City,	6	1	4	2	6	1	20
St. Mary's,	21	21	38	30	20	14	144
New England,	2	6	2	7	2	1	20
Homeopathic,	2	2	7	8	7	1	27
Massachusetts Infant's,	1	3	8	8	8	–	28
Miscellaneous,	3	3	10	11	6	7	40
St. Elizabeth,	1	1	1	–	4	2	9
Massachusetts Eye and Ear,	–	–	1	6	2	1	10
Carney,	1	–	–	1	–	–	2
Long Island,	–	2	2	1	–	4	9
Deer Island,	–	–	1	–	–	–	1
Boothby,	–	–	1	–	–	–	1
Baptist,	–	–	–	1	–	–	1
Deaconess,	–	–	1	–	–	–	1
Roger's,	1	–	–	–	–	–	1
Cushing,	–	–	1	–	–	–	1
Relief Station,	–	–	1	–	–	–	1
Des Bresey,	–	–	1	–	–	–	1
St. Carlo,	–	–	–	1	–	–	1
Sacred Heart,	–	–	–	1	–	–	1
Totals,	49	63	129	110	71	45	467
Percentages,	33	36	35.4	38.9	32.2	31.4	35

The ages of the victims are tabulated below: —

AGES.	June.	July.	August.	September.	October.	November.	Totals.
Less than 1 week,	33	42	41	40	42	39	237 = 17.9 per cent.
1 week to 1 month,	17	11	19	25	31	21	124 = 9.4 per cent.
1 to 3 months,	26	32	59	46	42	28	233 = 17.9 per cent.
3 to 6 months,	18	29	106	76	46	22	297 = 22.5 per cent.
6 to 9 months,	23	27	80	53	29	19	231 = 17.9 per cent.
9 to 12 months,	30	32	50	37	30	14	193 = 14.6 per cent.
Totals,	147	173	355	277	220	143	1,315

The cause of death is shown in the following table: —

CAUSE.	June.	July.	August.	September.	October.	November.	Total.
Congenital,	47	47	52	49	70	50	315
Prematurity,	19	24	23	24	33	23	146
Malformation,	17	13	16	16	24	14	100
Obstetrical,	8	8	4	9	9	13	51
Infectious diseases (not gastro-intestinal),	45	34	26	31	24	43	203
Gastro-intestinal,	40	80	257	190	111	42	740
Indefinite or unknown,	15	12	20	7	15	8	77
Totals,	147	173	355	277	220	143	1,315

Classification according to the mode of feeding was found to be rather difficult, because of the many methods and changes from one to another. Under "breast-fed" infants are included those that were fed thus throughout, or until taken to hospital, but not those taken to the hospital and there developing gastro-intestinal trouble. The cases classed as "combined" include those infants fed alternately at the breast and by bottle, but not those fed at first at the breast and later by the bottle. The cases classified as "bottle" are subdivided into three classes: (1) "modified" (those fed under hospital or other definite formulas, — not the "half and half and a little sugar" attempts at modification); "condensed" (condensed milk and water used almost entirely); "varia" (various and sundry articles of diet tried in succession as, for example, molasses and water, "just-food" gruels, milk and water with various additions). The cases classed as "not fed" include those infants that died at once without any evidence of digestive trouble. Four cases not found are grouped as "unknown."

Classification according to Feeding.

FEEDING.	June.	July.	August.	September.	October.	November.	Total.
Breast,	31	30	36	41	44	42	224
Bottle,	71	96	273	191	133	56	820
Modified,	27	37	80	63	52	25	284
Condensed,	1	5	24	6	4	2	42
Varia,	43	54	169	122	77	29	494
Combined,	10	12	14	14	12	9	71
Not fed,	33	33	32	31	31	36	196
Unknown,	2	2	–	–	–	–	4
Totals,	147	173	355	277	220	143	1,315

	June.	July.	August.	September.	October.	November.	Total.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Fed cases,	77.5	80.9	91.0	88.8	85.9	76.2	84.3
Not fed,	22.5	19.1	9.0	11.2	14.1	23.8	15.7
Fed cases:—							
Breast,	27.0	21.0	11.0	15.8	23.2	39.2	20.0
Combined,	8.0	8.5	4.3	5.6	6.3	8.4	6.3
Bottle,	65.0	70.5	84.7	78.6	70.5	52.4	73.7
Bottle and combined,	73.0	89.0	89.0	84.2	76.8	60.8	80.0

In the accompanying chart are shown the daily mean temperature, the daily incidence of cases and the proportion of bottle-fed and breast-fed victims.

SUMMARY.

The first fact to be noted in reviewing these figures is the increase in mortality as the temperature rises. The male infants seem to have suffered slightly more than the females, as commonly is the case, the excess of male births being overcome by a greater tendency among male infants to perish in the earlier months.

The percentage of colored victims, 2.2, is .5 higher than the percentage of the birth-rate (1.7 in Boston).

As the normal occurrence of twin pregnancies is less than 2 per cent., the proportion of twins among the deaths, 6.3 per cent., is significant.

No figures are given in the city reports to show the percentage of illegitimate births, but as a very large proportion of these cases are not cared for by the mothers, but are boarded at institutions or elsewhere, the percentage of this class that die is probably higher than that of the legitimate. Illegitimate children made up 7.6 per cent. of the deaths, — a proportion undoubtedly much higher than the ratio of illegitimate to legitimate births.

In studying the tables of distribution of the cases, the first fact to be noted is that about one-third of the cases each month are reported from hospitals. Consequently, the distribution of the other cases gives only a partial index of the true morbidity in the various wards of the city.

A study of the distribution of the cases with other ward figures brings out a number of interesting points. In East Boston (Wards 1 and 2) the birth-rate of Ward 1 is slightly higher than that of Ward 2, but the foreign-born population and congestion are greater in Ward 2, and in Ward 2 the infant death-rate for the period under consideration is considerably higher.

In Charlestown (Wards 3, 4 and 5) the ward having the highest birth-rate has the lowest infant death-rate; and the one with the highest infant death-rate is that which has the highest percentage of foreign-born population, the lowest birth-rate and the greatest congestion.

In Ward 6 is found the highest percentage of foreign born (mostly Italians), the greatest congestion, the highest birth-rate, and far and away the highest death-rate among the infants.

In Ward 11, the Back Bay region, only 8 cases were reported during the six months, — the smallest number for any ward of the city. These 8 cases, it is interesting to note, occurred in the region close to Cambridge Street, and during the six months not a single case of infant death was reported in a home in the area bounded by the State House, to Brookline, the Charles River and Boylston Street. In this area the birth-rate is unusually low, and a large proportion of the infants are taken out of town as soon as warm weather appears, and then, should they die, their deaths are reported elsewhere.

Ward 8 (the West End) stands next to Ward 6 in congestion and percentage of foreign population, and next but two in birth-rate; and yet there are only five wards in the city with a lower infant death-rate.

This ward is inhabited largely by Jews, and, as is well known, Jews usually nurse their infants.

Ward 13, which shows the highest infant mortality in South Boston, and the third highest mortality among all the wards, has the second highest ward birth-rate, is fairly congested, has a large foreign element of poor Irish and ignorant Poles, and a large number of filthy old tenements situated on made land but a few feet above sea level.

In examining the table of hospital cases, it will be kept in mind that the Infants' Hospital was closed during July, August and September, and that the Floating Hospital was in operation only from the first of July to the 14th of September.

Of all the cases recorded, there were reported from the hospitals during June, 33 per cent.; July, 36 per cent.; August, 35.4 per cent.; September, 30.9 per cent.; October, 32.2 per cent.; November, 31.4 per cent.; and during the six months, 35 per cent. The Floating Hospital reported in July 20 cases, or 31.7 per cent. of the hospital cases; in August, 47, or 36.3 per cent.; and in the first two weeks of September 23, or 35.9 per cent.; or 35.1 per cent. of the hospital cases reported while this hospital was running. In connection with this fact it should be noted that the average time that these cases were in the hospital was 10.3 days; that 21 of the cases were at the hospital for a day or less; and that 55 of the cases, or 61.7 per cent., were at the hospital less than a week.

St. Mary's Infant Asylum reported in June 21 cases, or 42.8 per cent. of the hospital cases; in July, 21, or 33 per cent.; in August, 38, or 29.4 per cent.; in September, 30, or 27.2 per cent.; in October, 20, or 28.1 per cent.; in November, 14, or 31.1 per cent.; making a total of 144 cases for the six months, or 30.85 per cent. of the hospital cases for this period, and 10.9 per cent. of the total cases of the city. In addition to these cases there were reported from the Boston City Hospital 7 cases brought in from St. Mary's in wretched condition, two of which died of diphtheria. There were 3 other reports of St. Mary's babies, one from the Eye and Ear Infirmary, one from East Boston and one from Brighton, where a baby eleven days old was left the night before it died. Making allowance for these cases, the report of cases of St. Mary's babies should be: in June, 24, or 48.9 per cent. of the hospital cases; in July, 22, or 34.9 per cent.; in August, 38, or 29.4 per cent.; in September, 34, or 30.3 per cent.; in October, 21, or 29.5 per cent.; in November, 15, or 33.3 per cent.; making a total of 154 cases, or 32.9 per cent. of the hospital cases and 11.7 per cent. of the total cases. Of these 154 cases, 60 were said to have been born at the hospital. With the exception of some of the cases born there, all but 20 were at the hospital for more than one month, and only one was at the hospital less than a week.

The tabulation of the cases by ages shows that, seemingly regardless of temperature, feeding or disease, about 40 babies under one week old die each month. During August and September, the months of highest mortality, the babies three to six months in age appeared to suffer most heavily, and those of six to nine months next in order. Those more than nine months old seem to have been much less affected.

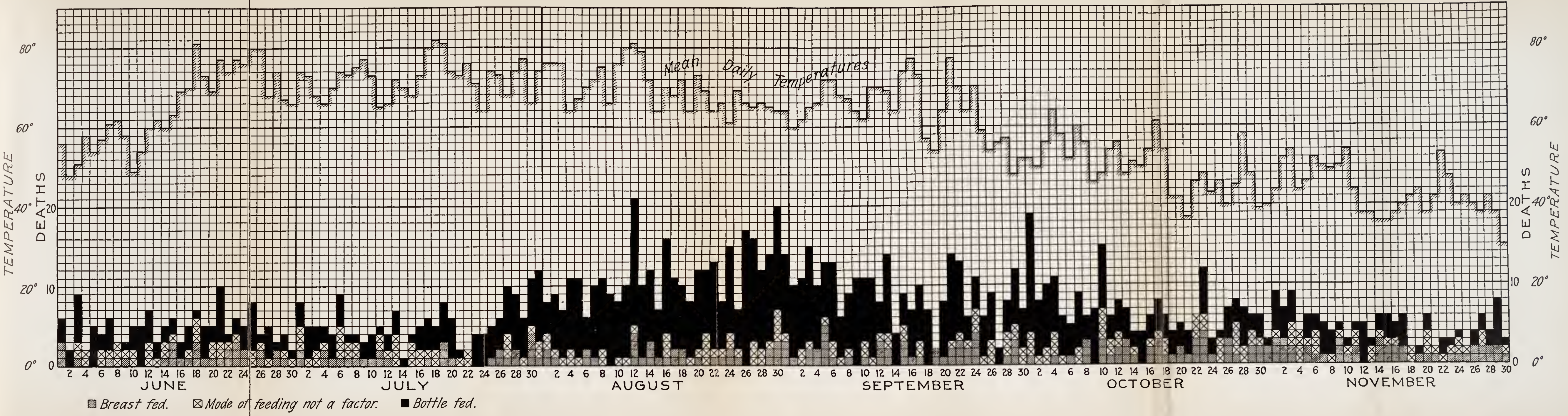
The table of causes of death shows that during the six months the number of congenital causes of death (prematurity, congenital heart trouble, obstetrical difficulties, etc.) remains about the same each month; the deaths from infectious diseases (not gastro-intestinal) show a decrease in August, but a decided increase in November, when the weather is colder and many cases of pneumonia are reported. The number of deaths from gastro-intestinal troubles, however, is twice as great in July as in June, and six times as great in August as in June; and then occurs a gradual decrease through September, October and November, as the weather becomes colder.

An analysis of the methods of feeding shows that 30 to 35, or 15 per cent. of the whole number of victims, died each month without having been fed at all. Of the remaining 84.3 per cent., a total of 20 per cent. were breast fed. The percentage of breast-fed cases decreases progressively with an increase in the total mortality, with corresponding increase in the percentage of bottle-fed cases. The number of deaths among those fed on modified milk was twice as great in August as in July, which suggests that dirty milk, no matter how scientifically modified, is not suitable food for babies.

The chart merely shows in a diagrammatic way the facts already considered. It shows perhaps more strikingly the rise in mortality with the rise in temperature, the close inter-relation between the mortality and bottle feeding, and the immunity given by breast feeding.

Many of the mothers who had ceased nursing their young were asked why they had done so. Their answers included: "Had to go to work;" "Not enough milk;" "Too busy;" "Took too much time;" "Breast abscess;" "Advised to do so by the doctor;" "In the family way again;" and "Inverted nipples."

An attempt was made to ascertain what efforts are being made by charitable organizations to supply proper milk to families in the poorer quarters, and it was learned that, in addition to the charitable work done by the various hospitals, there is a "milk fund" that supplies modified milk to applicants applying for treatment at the Children's


TEMPERATURE
DEATHS
80°
60°
40°
20°
0°
20
10
0
Mean Daily Temperatures
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
▨ Breast fed.
☒ Mode of feeding not a factor.
■ Bottle fed.

Hospital, the Infants' Hospital and the Boston Dispensary. One of the large contracting firms has five distributing stations, where pasteurized milk is sold in four, six, and eight ounce nursing bottles at 2 cents a bottle. The distribution during the summer was as follows: —

	Bottles.
Elizabeth Peabody House, 87 Poplar Street, Ward 8,	37,950
Denison House, 93 Tyler Street, Ward 7,	26,986
North End Union, 20 Parmenter Street, Ward 6,	82,551
South Bay Union, 640 Harrison Avenue, Ward 9,	11,258
Roxbury Neighborhood House, 858 Albany Street, Ward 9 (in September and October),	4,529
Total,	163,274

Conclusions.

The 1,315 infants that died in Boston during the six months may be grouped under five headings: —

1. Those who were predestined to die because of some congenital defect (parental weakness or parental sickness, prematurity, malformation, or obstetrical difficulty).

2. Illegitimate, and hence not welcome.

3. Abandoned, although legitimate, the parents being habitual drunkards or in extremely poor circumstances.

4. Those who acquired the common communicable diseases, as measles, whooping cough, etc.

5. Those improperly fed, either with foods naturally unsuited to infants' stomachs, or with polluted (dirty) milk, containing the common and usual exciting causes of that group of digestive diseases known generally as cholera infantum, but more properly as epidemic diarrhœa.

A reduction in the mortality due to improper feeding will take place only when physicians, nurses, mothers and the general public understand the importance of cleanliness of the milk supply from the moment of its production to that of its consumption. That 740 babies died in Boston during the six months of preventable gastro-intestinal diseases, due to improper feeding is proof of the need of a more wholesome milk supply.

REPORT

UPON THE

GROWTH OF PATHOGENIC BACTERIA IN MILK.

By HERBERT R. BROWN, S.B.

REPORT UPON THE GROWTH OF PATHOGENIC BACTERIA IN MILK.

By Herbert R. Brown, S.B.

Milk, containing as it does relatively large quantities of casein and milk sugar, smaller quantities of lactalbumin and several inorganic salts, meets the food requirements of most bacteria. It is at present impossible to say to what extent the fat content, consisting of some ten glycerides, aids or inhibits bacterial multiplication, but it is probable that it exerts no appreciable influence.

The bacterial content of milk from various sources, and even from the same animal, varies from day to day, according to season, environment during milking, association with other animals of the same or different species, change in pasture, standing in water of sufficient depth to permit the teats to come in contact with the surface, character of such water, and other conditions and circumstances. The general condition of health of the cow plays an important part, as does also the condition of health of the various persons who handle the product from the time of milking to that of use.

The bacterial content of milk has been the subject of much study by various men, among whom may be mentioned Conn and Esten (1901), who found *bacillus acidi lactici* I. and II., *bacillus lactis aerogenes, bacillus coli,* sarcina and streptococci quite regularly.

Lux (1903) reports *staphylococcus mastitis albus* to have predominated among the species present in milk examined by him. *Staphylococcus mastitis aureus, galactococcus versicolor, bacillus prodigiosus, bacillus luteus, bacillus acidi lactici, bacillus lactis aerogenes* and *bacillus coli communis* were the other types isolated. W. A. Stocking (1903), in a paper on the "Germicidal Action of Milk," refutes certain assertions that milk itself, by reason of the presence of certain ferments, exerts a germicidal influence during the first few hours. Stocking showed that in freshly drawn milk, non-acid-producing bacteria are present, and these, while regularly decreasing in number as time progresses, inhibit the growth of the lactic acid bacteria. The non-acid-producing bacteria decrease regularly from the first, while the lactic acid bacteria increase in numbers; consequently, there is represented at the intersection of the descending non-acid-producing bacterial curve and the ascending curve of the acid producers a bacterial content materially smaller than the original.

The decrease in the number of bacteria in milk subsequent to milking is attributed by Koning (1904) to the presence of certain toxic substances, probably of hematogenous origin. He states that there is no definite relation between the numbers of bacteria and the degree of acidity in market milk. The loss of CO_2, through which the acidity is reduced, is not replaced during the bactericidal stage by the production of lactic acid; it is not until the degree of acidity has passed a certain limit that there is a definite relation between the production of acid and the multiplication of lactic acid bacteria.

Thorner (1891) showed that 2.3 per cent. acid was the lowest degree of acidity at which milk would curdle on boiling. This degree of acidity I have observed to vary with different species of bacteria, while Thorner was probably working with a mixed flora.

Vandin (1892) reported that all kinds of milk was generally found to be acid, and that the degree of acidity varied but little in animals of the same species. The cause of the acidity was chiefly various protein substances, and the variations in acidity were due to changes in the nature and relative proportion of the same and the mineral elements of milk.

From the study of the literature dealing with the bacterial content of milk, the variation thereof, the multiplication of the germs under various conditions, such as fluctuations in temperature, the effect of freezing at various temperatures for different lengths of time on the vital resistance of the micro-organisms, and also, touching upon the presence of normal and bacterial enzymes, acid production and casein fermentation, we must conclude that the constituents of milk and the products of bacterial activity in such milk, some being of the same or similar nature, are certain to play an important part in the development of each specific micro-organism, either by favoring or by inhibiting its growth.

We may anticipate, especially, a variation in rapidity of multiplication with variation in the species. For example, when micro-organisms forming products of a nature favorable to the development of a certain bacillus predominate, we may expect a decided increase in numbers of that bacillus, with incubation at the optimum temperature; or, on the other hand, if a cell capable of producing substances of an inhibitory nature to the bacillus should gain supremacy, we must expect one of three possibilities: a complete stagnation of growth, resulting in no multiplication; a reduction in number, owing to the destruction of the less resistant individuals; or a complete suppression.

Growth of Pathogenic Bacteria in Milk.

The mode of entrance of the pathogenic bacteria to be discussed below into milk does not come within the scope of this paper, which deals chiefly with their multiplication after they have gained access. Medical literature is rich in information on this subject, and contains many proofs of the fact that human diseases of a communicable nature are frequently spread through the use of milk which has been contaminated by persons who are either diseased themselves or in contact with those who are, either directly or indirectly.

How many pathogenic bacilli originally gain entrance to the milk cannot be known; but, assuming that the numbers are relatively small, the number of persons who become attacked during an epidemic indicates that a considerable multiplication of the pathogenic bacilli in the milk must occur between infection and consumption.

All pathogenic bacteria flourish best at about body temperature; but lower and even freezing temperatures merely retard development, though some of the weaker bacteria gradually succumb. Only the most severe tests of freezing, thawing and refreezing can quickly destroy all of the specific micro-organism present, because of the fact that certain bacteria of all species are more resistant to physical changes than others, and the most vigorous will survive.

Milk has been used extensively as a culture medium for many years, and in order to render it sterile it is necessary to heat it at 100° C. a number of times. This degree of heat brings about certain changes in milk that render it somewhat different from normal; and, while these changes probably do not affect the cultural results, or even bacterial multiplication to any extent, it was deemed best to work with milk as nearly normal as possible, or with that which had been sterilized at relatively low temperatures.

According to Jensen and Plattner (1905), the first change takes place through prolonged heating at about 77.5° C. The lactalbumin is partly coagulated at 60° C., when the heating is prolonged for five hours, though the greater part is not precipitated below 70–75° C. Exposure to 77.5° C. for one hour, to 80° C. for thirty minutes and to 90° C. for five minutes produces complete coagulation of the lactalbumin. The authors report that the first critical stage in the changes in the casein molecule is at 80° C. for five minutes, 77.5° C. for one hour and 70° C. for five hours of prolonged heating; the second critical stage is 120° C. for five minutes and 110° C. for ten minutes. The minor changes may be due to the expulsion of CO_2, the destruction of the natural rennet, and the precipitation of lime salts. The fat fuses at temperatures above 120° C. and after five hours at 70° C.

In view of the chemical changes which occur at 77.5° C., experiments were made to attain sterilization of the milk at as low a temperature as possible.

The milk was heated at 60°, 65°, 70°, 75° and 80° C., according to the fractional method, in small flasks that were completely immersed in water at the desired temperature. The milk used was obtained from shops and from a dairy where the utmost care is exercised under the supervision of technically trained men.

At 60° C., spore-bearing anaërobic, spore-bearing aërobic (such as *b. subtilis, b. spinosus, b. ramosus, b. pseudœdema, b. pseudotetanus*) and non-spore-bearing bacteria of the streptococcus and diplococcus types were almost invariably found; occasionally, the grouping would be different, according to the predominance of one species over the others, or by reason of the absence of one or more of the types mentioned above. The diplococci and streptococci found were apparently unaffected by repeated heatings at 60° C., and one strain of streptococcus isolated was able to withstand 67° C. in bouillon for five minutes, but it was destroyed by exposure to 68° C. for the same time. Russell and Hastings (1902) describe a micrococcus having a thermal death point of 76° C., and capable of resisting this high temperature in any fluid. Other things being equal, milk may offer some protection to bacteria against heat, but until further experimental data is at hand nothing definite can be stated.

In this work, milk was frequently carried through twelve to fourteen days of fractional sterilization without the slightest sign of any change, and then would come a sudden precipitation of the casein. *Bacillus ramosus,* a spore-bearing aërobe that occurs commonly in the soil and in river and spring water, was generally found to be the causal agent. *Bacillus subtilis* on one occasion caused the milk to spoil after sterilization was supposed to be complete. The degree of heat used here was 100° C., according to the fractional method. The temperature of 36° C. used to induce spore formation in the case of the spore-bearing anaërobic bacilli and the obligatory aërobic bacilli such as *bacillus subtilis, bacillus pseudœdema* and like spore-bearing aërobes, apparently did not succeed when applied to *bacillus ramosus* and *bacillus spinosus.* The conditions of the flasks were of a partial anaërobic character, and it is possible that the oxygen requirements of these aërobes were not satisfied, so that with incubation at 36° C. no germination of the spores took place. In attempts at sterilization at 65° C. and 70° C. similar results were obtained.

Streptococci and diplococci were destroyed by the prolonged heating. *Bacillus subtilis, bacillus ramosus* and *bacillus spinosus,* in course of time, though often much delayed, caused a precipitation of the casein, and in the case of the hay bacillus there was a subsequent slow dissolution of the casein by the proteolytic ferments of that micro-organism.

At 75° and 80° C. and upwards, with less and less difficulty and more and more certainty of fruitful results, the milk was satisfactorily sterilized, unless there were present certain resistant anaërobic spores, which almost invariably occur in store milk during the summer months, which finally germinated.

Milk sterilized at 75° C., which is below the temperature at which the primary chemical changes in milk take place (77.5° C.), gives no sign of having been subjected to heat either in appearance or taste, and in all probability is certain to give as good results as milk sterilized at 60° C. At 80° C. there is a change in milk, as is evidenced by the slight brownish tint that is brought about; but from the results of the experiments there appeared to be no appreciable difference in the ability of bacteria to grow in milk sterilized at that temperature or at 75° C.

The method of sterilization at 75° C. was very similar to those followed in the attempts at sterilization at 60°, 65° and 70° C.

The milk was obtained as fresh as possible in the morning, and subjected to heat at 75° C. for thirty minutes during the forenoon in a rubber-stoppered Erlenmeyer flask of about 200 to 250 cubic centimeters capacity, by complete immersion in water heated to that degree. The expansion and contraction of the air in the neck of the flask, and the increase and decrease in volume of the milk, which reduced and increased the air volume with each process of heating and cooling respectively, were provided for by a glass tube, drawn out to a capillary end, which was passed through the perforated rubber stopper. In the afternoon of the same day the milk was again heated to 75° C. for the same length of time as before (thirty minutes), with the proper time allowance necessary to compensate for the slower rise of temperature of the fluid within the flask. The flask was removed and kept at room temperature after the first heating, and then kept over night at the same temperature after the second heating; room temperature during the summer months varied from 70° to 78° F., the lower temperature prevailing during the evenings. On the second day the milk received one heating at 75° C. for thirty minutes, and then was stored at room temperature until the afternoon of the following (third) day, when it was again heated and placed in the incubator at 36° C., to induce the germination of such spores as might be present.

On the morning of the fourth day, after a lapse of about sixteen hours, the flask was again subjected to heat to destroy the bacteria from the freshly germinated spores, and then replaced in the incubator and kept at 36° C. for twenty-four hours. The milk was heated again on the fifth day, and at this time sterilization was generally found to be complete; but in order to avoid any chance of error, the flask was replaced in the incubator, where it remained at 36° C. for at least a week before it was used.

Doubtless most of the streptococci, micrococci and non-spore-bearing bacilli were destroyed by the primary heating; but in order to destroy the individuals of slightly greater resistance, the second heating was given, and this being applied before they had recovered from the first shock of the sudden rise in temperature to 65°, 70° and 75° C., as the case might be, was almost invariably sufficient to kill, and thus complete the effect of the primary heating. The subsequent incubation and heating was to induce the germination of the spores of certain aërobic and anaërobic bacteria, and to kill the bacilli while they were in the vegetative condition; for at this time, before the protoplasm has begun to concentrate to form spores, we have to do merely with the individual resistance of the species, most of which is easily overcome by temperatures of 60° to 80° C.

The same method as that used for sterilization at 75° C. was also employed in sterilization at 80° C.

Sterile milk can be kept for indefinite periods, with but slight changes due to evaporation and slow precipitation of the coagulated lactalbumin. Bacteria seemed to develop equally well in milk a month to six weeks old as in newly sterilized milk.

The Growth of Specific Bacteria in Milk.

Bacillus Typhosus.

Chantemesse and Widal (1891) and Malvoz (1891) have reported that *bacillus typhosus* never coagulates milk, but that *bacillus coli communis* coagulates it in twenty-four to forty-eight hours in most cases. Cantley (1897) and Bolley and Field (1898) found that it can live only a few days in buttermilk. In 1898 Theobald Smith showed that it will grow in sterile milk and produce an acid reaction. In 1898 Bolley and Field inoculated sweet milk, sour milk and buttermilk with this organism, and reported: (*a*) that it remained alive for several months in cream and in buttermilk made from the same; (*b*) that there was no marked growth in buttermilk thoroughly worked; (*c*) that it developed in great numbers in sweet milk which became acid but did not coagulate; (*d*) that in mixed infections it was not outgrown, and in some cases became the predominant species. Kolle and others reported in 1904 that fresh milk drawn under aseptic precautions possessed no bactericidal properties for *bacillus coli, bacillus typhosus* and paratyphoid bacilli.

In the experimental work with the typhoid bacillus, two strains, numbered III. and VIII., were used, the former being one obtained some years ago, and the latter being the last one received at the laboratory.

Bouillon cultures twenty-four hours old were diluted by transfers to sterile bouillon, so that it was possible to add as many or as few bacilli to the milk as the experiment demanded.

The numbers of bacteria inoculated into the milk were immediately determined by plating on agar in the proper dilutions. The inoculated tubes were next exposed to 36° C., to room temperature, or about 21° C., and at a low temperature, such as 7° C. (45° F.), for varying periods according to the experiment; but the extent of multiplication was always determined at the end of forty-eight to seventy-two hours, for milk seldom reaches the consumer in large cities before it is at least forty-eight hours old.

Growth at 36° C. — 36° C. is the optimum temperature for most bacteria, and the typhoid bacillus proved to be no exception, for milk kept at this temperature proved to be most favorable to its development.

The number of bacilli of both strains in the milk immediately after inoculation from the diluted culture varied from 40 to 110 per cubic centimeter.

The tubes were placed at a constant temperature of 36° C. for forty-eight hours, after which the diluted milk was plated on agar and the number of colonies was estimated. The numbers were invariably raised to "countless" per cubic centimeter, the agar plates showing to the naked eye a very fine haze, which on microscopic examination showed colonies as numerous as the red corpuscles on a good blood smear on a slide or cover glass.

Growth at Room Temperature. — The temperature of the laboratory where the milk inoculated with typhoid bacilli was stored during incubation at "room temperature" varied from 71° to 78° F., or 21.7° to 25.5° C., at the time of the experiments. The milk was inoculated with similar numbers as before, varying from 40 to 110 to 120 per cubic centimeter. The results after forty-eight hours' exposure to this temperature again showed the presence of "countless" bacteria on the agar plates; but by microscopic examinations it was found that the colonies were in reality fewer in number than those on the plates representing the multiplication at 36° C. By longer incubation at room temperature the numbers rose until they equalled those found after forty-eight hours' incubation at 36° C.

Growth at Low Temperatures. — The experimental studies at low temperatures were carried on by storing the inoculated milk in the cold-storage vault of the Laboratory of Hygiene, Harvard Medical School, where the temperature varied from 5.6° to 6.7° C. (42° to 44° F.) during the course of the experiments. In the experiments at vault temperature a single loop of an undiluted twenty-four-hour bouillon culture incubated at 36° C. was added to the milk, in order to inoculate the medium with much larger numbers than before, because of the anticipation of a marked reduction in the numbers of the bacilli due to the relatively quick change from 36° to 5.6° to 6.7° C., which process, in itself, probably destroyed some of the weaker bacilli.

The number of bacteria added to the milk from the old strain (III.) was 1,436,580 per cubic centimeter, and that from the young culture (VIII.) was 1,499,040 bacteria per cubic centimeter.

The tubes were examined after about seventy-two hours' exposure to this temperature, and it was found that the bacteria of culture III. had been reduced to 94,920 per cubic centimeter, and those of culture VIII. to 16,420. Thus, exposure to low temperature had caused the destruction of 93.4 per cent. of the bacilli originally inoculated from culture III., and had destroyed 98.9 per cent. of those from culture VIII. The tubes were next examined after twenty-two days' exposure at the same temperature as before, and it was found that 9,945 bacteria per cubic centimeter of culture III. and 1,990 per cubic centimeter of culture VIII. were still alive; or, stated in percentages, 99.3 per cent. of the original number of culture III. and 99.87 per cent. of the original number of culture VIII. had been destroyed. From another point of view, it is seen that only 89.6 per cent. of the bacteria of culture III. present in the milk after seventy-two hours were destroyed, and but 87.9 per cent. of those of culture VIII.; showing that the rate of bacterial mortality was greater during the first seventy-two hours than during the following twenty-two days. In this connection it may be permissible to speak of the possible growth of some bacilli the numerical evidence of which was obliterated by the rapid reduction in numbers, as mentioned above. That the milk did change in reaction will be shown later on, and as this fact serves as evidence of bacterial activity, it may be possible that some of the more resistant members were unaffected by the cold and continued to multiply.

It is estimated that at 36° C. the rate of bacterial division was a complete fission of all cells in about two and one-half hours; at room temperature from three to three and one-half hours were required to complete the process of fission. These estimates, of course, give merely the average rate of division, for the actual rate in the beginning was much faster at both 36° C. and at room temperature; but as the changes were produced in the milk, there was of necessity a retardation in the rate of multiplication.

It is well known that cultures taken from a relatively old agar slant growth, when inoculated into a fresh, favorable medium, show a latent period before the beginning of active multiplication; and, as the milk under discussion was inoculated from twenty-four-hour bouillon cultures, the most active multiplication probably took place during the first few hours after the addition of the bacilli.

Changes produced in Milk as a Result of Bacterial Multiplication. — That *bacillus typhosus* does not behave the same in milk as in peptonized bouillon was conclusively shown in 1898 by Theobald Smith, who found that the bacillus produces alkali in bouillon, but not in milk. In milk the author found that there was a substance like dextrose present to the extent of about .1 per cent. A four days' growth of one strain showed 3.18 per cent. acid for the bulb and 3.06 per cent. acid for the branch fluid of a fermentation tube, the original reaction of the milk being 1.74 per cent. acid to phenolphthalein; another strain in five days' growth gave in the bulb 3.07 per cent. acid and in the branch fluid 3.04 per cent., the control in this case showing an acidity of 2.04 per cent. There was no coagulation of the milk.

In the experimental work upon typhoid it was found that the milk sterilized at 75° C. was 1.3 per cent. acid to phenolphthalein, and this acidity was raised to 1.95 in seven days' growth at room temperature after inoculation with culture III.

There was no change in forty-eight hours at room temperature. Culture VIII. in the same experiment produced no change in forty-eight hours, but at the end of seven days the reaction was found to be 1 per cent. acid to phenolphthalein. With another lot of milk, sterilized in this instance at 100° C., culture III. caused a rise in the acidity from 1.5 to 2.75 per cent. to phenolphthalein in the branch, and no change in the bulb; culture VIII. in milk of the same lot produced enough acid to raise the branch to 2.45 per cent., while the bulb reaction was reduced to .7 per cent. acid, using phenolphthalein as an indicator.

As has already been noted by Smith and Bolley and Field, no coagulation appeared either spontaneously or on boiling. Thorner (1891) stated that 2.3 per cent. acid is the lowest amount which will curdle milk on boiling; but he was evidently working from the chemical side only, and had to do with the normal store milk, heavily loaded with mixed cultures of bacteria.

In the case of typhoid bacilli and a number of related forms, together with certain anaërobic bacilli, there is no precipitation of the casein on boiling, even though the acidity is high. With high acid reaction, other bacilli may spontaneously produce a precipitation of the casein that is only seen with the aid of the microscope, but may be rendered evident to the naked eye by the application of heat, which causes an agglutination, so to speak, of the fine particles into coarse masses.

The addition of sterile neutral litmus to the milk gave a slight indication of the rise in acidity, but the information derived was so indefinite that experiments along this line were purposely limited. The positive pink color to litmus milk after a forty-eight-hour incubation at 36° C., or for a slightly longer period when kept at room temperature (21° to 22° C.), was easily obtained with both culture III. and culture VIII.; at vault temperature (5.6° to 6.7° C.) the milk remained neutral to litmus during the first three to three and one-half days; but after twenty-two days both strains had produced acid reactions in the respective tubes, with the greater intensity, as shown by the litmus, in favor of the young strain (VIII.). As pointed out in another connection, this acidity may have been produced by bacterial multiplication that ceased, or it may possibly have been produced by the old bacilli whose lives were slowly ebbing away; and, while the rates of food absorption and waste excretion were much retarded, nevertheless the processes themselves did not cease entirely.

General Summary and Conclusion. — The study of the literature on the growth of *bacillus typhosus* showed several important facts of more or less direct bearing on the subject. It is shown that *bacillus typhosus* can remain alive for several months in cream and in buttermilk made from the same; that it develops in great numbers in sweet milk which becomes acid but is not coagulated; that freshly drawn milk has no bactericidal power against it or against paratyphoid or *bacillus coli;* and that in mixed infections it is, in certain cases, not only not outgrown, but may become the predominant species. Comparative studies of milk and peptonized bouillon seem to point toward the latter as a more favorable medium.

From the experimental studies it is proved that *bacillus typhosus* multiplies rapidly in milk incubated at 36° C. from a very few bacteria per cubic centimeter to countless numbers in forty-eight hours. The multiplication is accompanied by acid production, but otherwise no change can be detected in the milk. When inoculated milk is kept in test tubes for thirty to sixty days or more at room temperature, or presumably for a shorter period at 36° C., it becomes strongly alkaline. The multiplication of *bacillus typhosus* is slower at room temperature than at 36° C., and consequently a longer period than forty-eight hours is required to produce the same numbers of bacteria per cubic centimeter and the same degree of acidity. Storage at low temperatures between 41° and 45° F. caused a marked reduction in the numbers of bacteria in seventy-two hours, but produced no change in reaction. Continued exposure to the low temperature showed a continued destruction of bacteria, but the rate of destruction became slower as time passed.

It is only on excessively hot days that milk would be exposed to such a temperature as 36° C., which is known to be the optimum for *bacillus typhosus;* but it is important to know definitely how this micro-organism behaves in milk so exposed, in order fully to appreciate the increase in danger from milk that has been infected in the process of handling and not kept cold.

At ordinary temperatures of 72° F., or thereabouts, the multiplication being slower, the increase in danger to the consumers becomes slower, but none the less certain.

On account of the omission of icing milk in transit, the bacteria have abundant opportunity to multiply; and from calculations based on the difference between the originally inoculated numbers of bacteria and the resulting numbers after forty-eight hours' growth at room temperature, it is estimated that they double their numbers about every three to three and one-half hours. This is the average rate, and the estimate does not take into consideration the existence of the latent period that usually precedes bacterial development when a transfer is made from one medium to another.

The temporary icing by storekeepers can produce little effect, if any, on the numbers of typhoid bacilli that might originally be present in milk, except in the way of retarding multiplication. As has been shown above, it is only with long-continued exposure at low temperature that appreciable reduction in the numbers can be brought about. That there may be some multiplication of typhoid bacilli in milk is quite possible; and the rise in acidity in milk inoculated with this bacillus when exposed to low temperatures (5.6° to 6.7° C.) for many days points toward a probable adaptation of certain individual bacteria to the low temperature.

Paratyphoid Bacillus.

In order to incorporate the study of a closely related member of this group, the paratyphoid bacillus of a strain isolated from the gall bladder of a man was secured and inoculated into milk sterilized at 75° C.

Milk and whey have been extensively used by many workers in the differentiation of this bacillus from *bacillus typhosus*. Schottmüller reports that there is an acid production in whey, and that subsequently the reaction becomes alkaline. There seems to be no difference in the opinion of different authors concerning this general effect, but the conclusion arrived at is that practically all strains differ to a greater or lesser extent from one another, so that it becomes impossible to state anything definitely that will apply to all cultures.

In the experimental studies, relatively small numbers of bacteria were inoculated into milk, which was then incubated at 36° C. and at room temperature for varying periods, according to the experiment. At 36° C. there was a very luxuriant growth, the number of bacteria per cubic centimeter being raised from 3,530 to "countless" in forty-eight hours.

The multiplication at room temperature, while less in extent, was likewise luxuriant, the numbers being raised from 3,530 per cubic centimeter to "countless" in forty-eight hours. Microscopic counts showed "countless" to be approximately 25,000,000 and 21,000,000 per cubic centimeter respectively.

It is distinctly shown that the optimum temperature is nearer 36° C. than room temperature, but that the lower temperature is far from unfavorable.

The original reaction of the sterile milk was 1.3 per cent. acid to phenolphthalein, and the reaction after forty-eight hours' incubation at 36° C. and at room temperature stood at 1.35 per cent. acid, thus showing a rise of .05 per cent. There was no coagulation on boiling. After one week the milk had lost its white, porcelain-like opacity, and had become slightly translucent and opalescent in character. The progressive changes that take place in the milk after inoculation are most interesting and instructive. Starting with the primary opacity, the milk first becomes slightly opalescent, which in turn gives way to a slight translucence, to translucence, to marked translucence, with a coloring bordering on a yellowish-brown of ever-increasing intensity, until at the end of twenty-eight days the milk becomes very similar to moderately deeply colored peptonized bouillon of a moderately cloudy nature. The cream was found to be unaffected, beyond the formation of a fine emulsion. Both lots of milk gave positive biuret tests, showing a peptonization of the proteid content by the proteolytic ferments formed. There was no coagulation of the milk on boiling after incubation for four weeks.

General Summary and Conclusion. — At room temperature, and at the temperature of the thermostat, the growth of paratyphoid bacilli is luxuriant; and after forty-eight hours' incubation at either temperature, millions of bacteria per cubic centimeter are to be found in the milk that previously contained but few.

There is, as would be expected, a larger number of bacteria in the milk incubated at the higher temperature than in that kept at the lower. Accompanying the growth are chemical changes marked by an initial rise in acidity, which gives way to a marked alkaline reaction as time progresses beyond the sixth to seventh day. The milk first assumes a slightly opalescent appearance, and, by a series of slow transitional changes, finally becomes a slightly cloudy yellowish-brown translucent fluid. These changes are due partly to the alkaline reaction, and partly to the digestion or peptonization of the proteid constituents of the milk by the proteolytic ferments formed by the paratyphoid bacilli. No coagulation is produced in milk at any time during the incubation periods, either spontaneously or on boiling.

Hog Cholera Bacillus.

The hog cholera bacillus, being closely allied to the foregoing types, was next taken up for study. It has been shown that the hog cholera bacillus multiplies in milk, and as the number of bacteria increases there is found a change in the microscopic appearance of the fluid. Theobald Smith, in the early days of the study of this micro-organism, noted and reported that the milk assumed a slightly opalescent and partly translucent character with prolonged incubation; he also showed that, with four days' incubation of milk in fermentation tubes after inoculation with this bacillus, there was produced an alkaline reaction in the bulb and an acid reaction in the branch. The original reaction of the milk was 1.74 per cent. acid, and after incubation the bulb was .64 per cent. acid and the branch 3.19 per cent. acid, with phenolphthalein as an indicator. With another strain of hog cholera, the reactions after nine days' growth were 0 for the bulb and 2.68 per cent. acid for the branch, the original acidity of the milk in this case being 1.66 per cent. acid to phenolphthalein. Moore reported that the hog cholera bacillus saponifies milk in three to four weeks; De Schweinitz, that milk becomes watery in three weeks' time, and has a neutral or alkaline reaction; Caneva claims a peptonization of the milk without previous coagulation; Dempser attributes the alkalinity of old milk cultures to the activity of ferments.

Bunzl-Federn obtained the same result as Theobald Smith, and working with litmus milk he reports that two days' incubation produced a slightly red color; eight to ten days, an intense blue color; and seven months (?) caused the lower layers to become much diluted. Others have given similar reports at various times concerning the behavior of the hog cholera bacillus in milk.

Macfadyen, working with the same strain as was used in the experimental work of this paper, reported that the bacillus produced a toxin that killed a rabbit in five hours by the intravenous injection of 1 cubic centimeter, and that .5 cubic centimeter was fatal to mice injected intraperitoneally.

With these facts in mind, experiments were made to determine the rate and extent of the multiplication of this bacillus in milk. Milk sterilized at 75° C. was inoculated with not over 40 bacteria per cubic centimeter, and incubated for forty-eight hours at room temperature, which varied from 72° to 78° F.

The numbers were increased to "countless" per cubic centimeter, but at that time there had been produced no microscopic change in the appearance of the milk. In another lot of milk the original numbers of bacteria (116,592 per cubic centimeter) inoculated were raised to "countless" per cubic centimeter in eighty-four hours. The longer period of incubation in this case was required in order to be able to compare the results with those obtained from milk stored at cold temperatures.

At the lower temperatures (5.6° to 6.7° C.), the milk after eighty-four hours' exposure was found to contain a greater number of bacteria than when the exposure began. The number of bacteria added was 116,592 per cubic centimeter, and after eighty-four hours this figure had increased to 141,363, — an increase of 24,771 to each cubic centimeter. After twenty-two days the numbers were found to have fallen off to 19,513 per cubic centimeter, showing that there had been a more or less rapid destruction of 121,850 bacteria whose vital resistances were insufficient to meet the demands of the exposure to low temperatures.

The rate of multiplication during the first eighty-four hours in milk incubated at room temperature was quite rapid, there being an average complete fission of all bacteria each four and four-tenths hours. At vault temperature (5.6° to 6.7° C.) not all bacteria grew, and only the more resistant individuals were able to flourish, those of less vital resistance merely existing in a torpid condition without multiplication during the first period of eighty-four hours, and later succumbing to the continued exposure.

Litmus milk kept cold and at room temperature remained neutral in reaction during the first eighty-four hours. After twelve days the litmus milk kept at room temperature had assumed a grayish-blue color, but was otherwise normal.

With continued exposure to favorable temperatures, the litmus milk became of a deeper and deeper shade of blue, but when kept at vault temperature (5.6° to 6.7° C.) the reaction remained neutral all the time, because of the retarded multiplication of the bacilli and the accompanying slow accumulation of the products of bacterial activity. After nine weeks' incubation at room temperature, the litmus milk had become intensely blue in color in the upper layers, while the lower parts were brownish. The reaction of the milk at this time was found by titration, using litmus as an indicator, to be 7.5 per cent. alkaline.

The reaction changes during the first forty-eight hours' growth were very slight, the acidity being raised from 1.3 to 1.35 per cent.; and this was reduced by seven days' incubation at room temperature to 1.25 per cent. acid, phenolphthalein being used as an indicator.

There was no coagulation of the milk at any time, or under any condition of temperature, either spontaneously or on boiling.

The prolonged incubation of the milk after inoculation with the hog cholera bacillus caused the fluid slowly to assume an opalescent and later a slightly translucent appearance, due to the alkali production, and possibly, as is claimed by Caneva, a slight digestion of the proteids present.

General Summary and Conclusions. — The experimental studies show that there is a profuse multiplication of hog cholera bacilli in milk kept at room temperature, and that even at low temperatures (5.6° to 6.7° C.) the more resistant forms appear to be capable of multiplication, as was shown by an increase in numbers during the first eighty-four hours' exposure. With prolonged exposure the less resistant forms are slowly destroyed, but from the reports of long exposure of members of closely related groups to very low temperatures, it may be assumed that some bacilli of the hog cholera species would be able to withstand similar treatment.

In forty-eight hours at room temperature there was found an initial rise of acidity in milk from 1.3 to 1.35 per cent., using phenolphthalein as an indicator; after seven days this reaction had fallen off to 1.25 per cent. acid.

With incubation at room temperature for nine weeks the reaction was found to have fallen to 7.5 per cent. alkaline, using litmus as an indicator.

Milk kept at low temperatures (5.6° to 6.7° C.) remained neutral to litmus for twenty-two days, when the tubes were rejected.

The general changes take place in a regular way: at first there is an opalescent appearance, which later gives way to a slight translucence; and this in turn increases in intensity in a manner like that observed with milk inoculated with the paratyphoid bacillus.

Bacillus Dysenteriæ (Shiga).

As the dysentery bacillus plays an important part in intestinal disturbances, and especially so during the warm months of the year, it was deemed advisable to study its multiplication in milk. Shiga, Kruse and numerous others have separately isolated dysentery bacilli, and their cultures have been divided by Hiss into four groups, according to their action on sugars and the alcohol mannit. Types of two groups show an initial acidity, which is followed by a return to the original color of litmus milk in six to eight days. The cultures of Shiga and Kruse, the former being used in the experimental work of this paper, act in a similar way, but do not produce as much alkali, and in this respect approach the typhoid bacilli in character. Shiga observed that milk did not coagulate; Flexner found that lactose was not "gaseously" fermented, but that litmus milk assumed a faint lilac tint in twenty-four to seventy-two hours; Kruse found a growth in milk similar in nature to that of *bacillus typhosus;* and others report practically the same results.

All authors seem to agree in the opinion that there is a slight rise in acidity during the early hours of incubation, followed by an alkaline reaction and no coagulation, but none speaks of the rate or extent of the growth.

In the experimental studies, milk sterilized at 75° C. was inoculated with *bacillus dysenteriæ* (Shiga), and incubated at 36° C. and at room temperature (68° to 72° F.) respectively for forty-eight hours. When the tubes were kept at 36° C., the original numbers of bacilli were raised to "countless" numbers per cubic centimeter ("countless" = 13,260,260 bacteria per cubic centimeter, as calculated from microscopic counts). At room temperature the increase in numbers did not approximate that found at 36° C., but there was a definite multiplication as high as 1,413,760 bacteria per cubic centimeter. The rate of multiplication was naturally more rapid at 36° C. than at room temperature, the former stimulating the complete fission of all bacteria in two and three-tenths hours, while the latter gave a complete division of all cells in three and seven-tenths hours. The chemical changes produced were most apparent in milk incubated at 36° C. At 36° C. there was a rise in acidity from 1.3 to 1.95 per cent., while at room temperature, after exposure for the same length of time (forty-eight hours), the reaction was 1.4 per cent. acid, showing a rise of only .1 per cent.

Milk incubated at 36° C. for twenty-eight days was found to give a reaction of 1.75 per cent. acid to phenolphthalein, and did not coagulate on boiling.

Control tubes of milk subjected to the same treatment as the inoculated tubes remained normal.

Summary and Conclusions. — From the study of the literature, it was found that all authors agree that the dysentery bacillus can grow in milk, and that it produces an initial acidity in the medium which is followed by an alkali production, the quantity of which varies with the culture used.

There is no "gaseous" fermentation of sugars and no coagulation of milk.

From the experimental studies it was found that there was a luxuriant growth of *bacillus dysenteriæ* (Shiga) in milk incubated at 36° C. (the optimum temperature) and at room temperature (68° to 72° F.).

At 36° C. the numbers of bacteria were raised from not over 160 per cubic centimeter to 13,260,260 per cubic centimeter, and at room temperature from 160 to 1,413,760 bacteria per cubic centimeter, by forty-eight hours' incubation.

The highest degree of acidity produced in milk incubated at 36° C. was 1.95 per cent., but this degree of acidity was insufficient to produce coagulation, even on boiling. The tendency toward subsequent alkali production renders the chances for precipitation of the casein less and less as time progresses. Milk kept at room temperature showed .1 per cent. rise in acidity in forty-eight hours, but later there was a greater rise in acidity as growth went on.

Bacillus Diphtheriæ.

That the diphtheria bacillus can grow in milk seems to be the universal opinion of all workers in bacteriology, but there exists some lack of agreement in regard to a few details of specific points.

In 1896 Schottelius maintained that this bacillus can grow better in fresh than in sterilized milk, which Montefusco denied, reporting a better growth in sterilized milk than in fresh. Feinberg found a greater multiplication of diphtheria bacilli in raw milk than in sterilized milk; and he and Blumenthal reported that it can split lactose into alcohol, aldehyde and volatile and non-volatile acids. Zarniko reported that it can grow equally well in milk and in bouillon.

In the experimental work two strains of bacilli were used, one young and one old culture being selected.

The methods were the same as above, small or large numbers of bacteria being inoculated into milk sterilized at 75° and 80° C. The number of bacilli from the old strain inoculated into milk varied from 0 to 30 per cubic centimeter, and that of the young strain from 0 to 60 per cubic centimeter.

Growth at 36° C. — After inoculation, the respective tubes were placed in the thermostat at 36° C. for forty-eight hours, when the extent of multiplication was determined by plating on agar. The old laboratory strain showed a greater adaptation to milk than did the young one, but neither multiplied as freely as the other organisms. In forty-eight hours the numbers of bacteria per cubic centimeter varied from 128,499 to "countless" numbers in the case of the old strain, according to the original numbers added. The young strain showed about one-fifth as many bacteria per cubic centimeter after forty-eight hours' growth, the numbers in two experiments being 19,282 and "countless." Milk that contained less than 20,000 at the end of forty-eight hours showed "countless" bacteria after ninety-six hours' growth.

It was estimated that the rate of multiplication in the case of the old culture was the more rapid, the bacteria doubling in number each two and six-tenths hours and three hours respectively during the first forty-eight hours; but, while the rate was materially lessened during the next forty-eight hours with both strains, the order was reversed, the bacilli of the young strain undergoing fission about each seven hours, as against eight hours in the case of the old. The reversal in rate of multiplication is to be explained by calling to mind that the primary consumption of available nutritious foods was more rapid with the old strain than with the newer, and, the original quantities being the same, an equalization in numbers and end products was more or less certain to take place with continued incubation.

Growth at Room Temperature. — During the course of these experiments the room temperature varied from 72° to 78° F., which limits represent in a general way the temperatures of night and day respectively. Both strains showed a smaller increase in number per cubic centimeter after forty-eight hours' incubation, as compared with the figures representing the growth at 36° C. Starting with but 30 and 60 bacteria per cubic centimeter, with the old and new strains respectively, it was found after forty-eight hours' incubation at room temperature that the milk contained 2,850 and 1,890 bacteria per cubic centimeter; in another instance, after the inoculation of much larger numbers and incubating for about eighty-four hours, the numbers of bacilli of the old strain were raised from 5,481 to "countless" bacteria per cubic centimeter ("countless" = 2,238,850 by calculation from microscopic counts), and those of the younger strain were raised from 9,716 to "countless" per cubic centimeter ("countless" = 2,791,210 by calculation from microscopic counts). The rate of multiplication by calculation was found to be more rapid under any condition with the older strain.

By inoculation of small numbers of bacilli it was found that the bacilli of the older strain doubled each six and four-tenths hours, while those of the younger required nine and six-tenths hours. The inoculation of large numbers caused the bacilli to divide less often, the older strain requiring nine and six-tenths hours of all bacteria, and the younger ten and one-tenth hours for complete fission.

The increase in time required to bring about complete fission of all bacteria, when large numbers were added in the inoculation, was probably due to consumption of the available nutriment by large numbers of bacilli instead of a few, and the natural inhibitory effect of an over-population and a more rapid accumulation of waste products in the milk. It is no more than would be expected when small numbers of bacteria, placed in a favorable culture medium, kept at a reasonably favorable temperature, grow at a greater rate during the first few days when the inhibitory agents are absent than at a later period when the medium is over-populated and these agencies are becoming predominant.

Growth at Low Temperatures. — The temperature obtaining in the experiments was the same as before (5.6° to 6.7° C.). Relatively large numbers of bacteria from each strain were added to the sterile milk, and the multiplication was determined after eighty-four hours and after twenty-two days. Both cultures showed a slight multiplication during the first period, but a general reduction in numbers in the second period.[1] From the old strain they increased from 5,481 to 8,440 per cubic centimeter in eighty-four hours, but at the end of twenty-two days only 60 bacteria per cubic centimeter were found; the younger strain showed a slight increase of 300 bacteria per cubic centimeter in eighty-four hours, or a rise from 9,700 to 10,000 per cubic centimeter, and after twenty-two days 3,260 bacteria per cubic centimeter still remained. The increase in numbers during the first period counts for little, except to tell us that there was no dying off of the bacilli in the time mentioned.

The old strain of diphtheria was thus shown to be much more susceptible to exposure to cold than the young culture, but the reason for the difference is at present obscure.

Changes produced in Milk by Bacillus Diphtheriæ. — The more rapid the multiplication of bacteria, the more rapid the changes in the medium, and accordingly, at 36° C., litmus milk inoculated with the respective diphtheria cultures had turned to a bluish-gray in forty-eight hours, and so remained up to fifteen days, when the tubes were discarded.

There was no evidence of any acid production when litmus was used, but by titration of the milk of another experiment it was found that the acidity had been raised .05 per cent. with the old strain, and the reaction of the milk inoculated with the younger remained the same as the original acidity after seven days' incubation.

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[1] The milk, previous to inoculation, had been kept at room temperature, and it is possible that the slight multiplication noted took place while the temperature of the fluid was being slowly reduced to that of the cold vault, and that there was no multiplication after the temperature of the milk had been reduced to 5.6° to 6.7° C.

Microscopic examination of the milk showed no coagulation, and the application of heat brought about no precipitation of the casein.

Milk kept at room temperature is noted as having shown no change until twenty-two days after inoculation, when the medium became alkaline to litmus; the degree of alkalinity continued to increase very slowly, so that at the end of nine weeks the reaction was 1.35 per cent. alkaline with the old and 1.45 per cent. alkaline with the younger strain.

At the vault temperature (5.6° to 6.7° C.) no changes in reaction were found.

General Summary and Conclusions. — Many authors report that *bacillus diphtheriæ* can grow in milk, and the above experiments show definitely that the bacillus does multiply in the medium, but at a slower rate and less vigorously than some other pathogenic bacteria.

Three authors seem to disagree on the point that heat affects milk in such a way as to render it unfavorable to the growth of this bacillus. Schottelius holds that *bacillus diphtheriæ* can grow better in fresh milk than in sterilized, and Feinberg agrees with him; Montefusco claims a better growth in sterilized milk than in the raw product. The first-mentioned author offers experimental data in support of his view, while Montefusco gives none. As applied to the ordinary commercial milk, this point of contention amounts to nothing, for the luxuriance of growth of the diphtheria bacillus must vary with the variation in the species representing the bacterial flora of each lot of milk into which the organism is inoculated.

Growth at 36° C. was more luxuriant than at room temperature, but at both there was definite multiplication.

At low temperatures (5° to 7° C.) the bacteria were not reduced in numbers in forty-eight hours, and there was evidence of a slight multiplication in that period, which probably took place during the interval required to lower the temperature of the milk to 5.6° to 6.7° C. The changes occurring in milk inoculated with *bacillus diphtheriæ* are merely those of reaction, there being a slight rise in acidity within the first forty-eight hours, when incubation is carried on at a favorable temperature; this is followed by a slow production of an alkaline reaction with prolonged exposure. It has been shown that *bacillus diphtheriæ* can produce toxin in milk, and that the process goes on better at a low temperature than at a high one; but, generally speaking, the medium is not as favorable as bouillon for the production of diphtheria toxin. It was deemed impracticable to carry on experiments on toxin formation in milk, for it may be assumed that growth is accompanied by the formation of this product.

Summary of Results.

1. *Bacillus typhosus,* paratyphoid, hog cholera, *bacillus dysenteriæ* (Shiga) and *bacillus diphtheriæ* can all grow in milk, but the last grows the poorest of the five when placed under the optimum conditions of temperature.

2. All species grow less luxuriantly at room temperature than at 36° C.

3. Exposure to low temperatures (5.6° to 6.7° C.) causes no appreciable destruction of bacteria during the first forty-eight hours, and there may even be some multiplication of the more vigorous individuals of all five species. Continued exposure for three weeks causes a rapid destruction of the individual bacteria most susceptible to the low temperature.

4. *Bacillus typhosus* produces an acid reaction in milk early in its development. The milk remains normal in appearance.

5. Bacillus hog cholera and the paratyphoid bacillus produce an initial rise in acidity, which is followed by alkali production as an end product. The milk assumes a primary opalescent appearance, which later on is changed to a translucence due to alkaline reaction and probable peptonization of the proteids present.

6. *Bacillus dysenteriæ* produces a slight initial rise in acidity, which is followed by a return to a slightly alkaline reaction. The milk remains normal in appearance.

7. Exposure of *bacillus typhosus* to —1.1°, —12.2°, 17.8° and 21.1° C. for fourteen days did not kill all the bacteria of any one tube, for growth always ensued when the culture was placed in favorable environment.

REPORT

UPON THE

PRODUCTION AND DISTRIBUTION OF DIPHTHERIA ANTITOXIN AND VACCINE VIRUS

FOR THE

YEAR ENDING NOV. 30, 1907.

REPORT

UPON THE

PRODUCTION AND DISTRIBUTION OF DIPHTHERIA ANTITOXIN AND VACCINE VIRUS

FOR THE

YEAR ENDING NOV. 30, 1907.

The production of diphtheria antitoxin and vaccine has continued under the direction of Dr. Theobald Smith, at the laboratory of the State Board of Health, at Forest Hills. The distribution has been conducted, as before, at the office of the Board.

The total number of packages issued by the Board during the twelve years and eight months ended Nov. 30, 1907, was as follows: —

	Bottles.
In 1895–1896 (year ended March 31),	1,724
In 1896–1897 (year ended March 31),	3,219
In 1897–1898 (year ended March 31),	4,668
In 1898–1899 (year ended March 31),	12,491
In 1899–1900 (year ended March 31),	31,997
In 1900–1901 (year ended March 31),	53,389
In 1901–1902 (year ended March 31),	40,211
In 1902–1903 (year ended March 31),	33,475
In 1903–1904 (year ended March 31),	41,133
During six months ended Sept. 30, 1904,	22,255
In 1904–1905 (year ended Sept. 30, 1905),	47,387
During fourteen months ended Nov. 30, 1906,	70,424
In 1906–1907 (year ended Nov. 30, 1907),	64,807
Total,	427,180

The serum was distributed to local boards of health, to hospitals, and to practitioners in 201 cities and towns, 68 of which used more than 100 bottles each. The following table shows the distribution: —

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1906, to Nov. 30, 1907.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Abington,	372	Braintree,	103
Acton,	8	Bridgewater,	60
Adams,	265	Brimfield,	6
Amesbury,	110	Brockton,	1,152
Amherst,	6	Brookfield,	6
Andover,	12	Brookline,	475
Arlington,	74	Cambridge,	2,106
Ashburnham,	6	Hospital,	75
Athol,	36	Stillman Infirmary,	12
Attleborough,	54	Canton,	25
Avon,	6	Chelsea,	731
Ayer,	20	U. S. Marine Hospital,	6
Barnstable,	6	Cheshire,	6
Barre,	36	Chester,	12
Bedford,	10	Chesterfield,	6
Belmont,	78	Chicopee,	170
Massachusetts School for the Feeble-minded.	12	Clinton,	199
McLean Hospital,	4	Cohasset,	36
Berkley,	12	Colrain,	6
Beverly,	206	Concord,	36
Blackstone,	12	Cummington,	6
Boston: —		Dalton,	42
Boston City Hospital,	5,548	Dana,	2
Boston Lying-in Hospital,	45	Danvers,	323
Children's Hospital,	2,275	Dedham,	115
General supply,	9,950	Dighton,	18
Infants' Hospital,	126	Douglas,	24
Home for Destitute Roman Catholic Children.	49	Dudley,	24
Massachusetts Charitable Eye and Ear Infirmary.	18	East Bridgewater,	72
Massachusetts General Hospital,	200	East Longmeadow,	36
Massachusetts Homœopathic Hospital.	423	Easton,	48
Massachusetts Infant Asylum,	62	Edgartown,	6
Parental School,	150	Erving,	12
Saint Mary's Infant Asylum,	302	Essex,	30
Training ship "Enterprise,"	24	Everett,	374
Boylston,	12	Fall River,	600

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1906, to Nov. 30, 1907 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Fitchburg,	300	Littleton,	10
Foxborough,	104	Lowell,	2,344
Framingham,	36	Ludlow,	6
Franklin,	25	Lynn,	3,302
Gardner,	81	Malden,	527
Georgetown,	61	Manchester,	42
Gloucester,	850	Mansfield,	60
Grafton,	18	Marblehead,	110
Great Barrington,	24	Children's Island Sanatorium,	86
Greenfield,	6	Marlborough,	124
Groton,	6	Marshfield,	12
Hadley,	18	Maynard,	12
Hamilton,	118	Medfield,	42
Hanover,	24	Medford,	372
Hanson,	12	Medway,	24
Hardwick,	162	Melrose,	204
Hatfield,	46	Methuen,	133
Haverhill,	940	Middleborough,	12
Hingham,	195	Milford,	204
Holbrook,	172	Millbury,	60
Holden,	12	Millis,	18
Holyoke,	833	Milton,	179
Hopedale,	49	Monson,	42
Hopkinton,	258	Natick,	132
Hudson,	304	Needham,	86
Hull,	28	New Bedford,	1,040
Huntington,	30	Newbury,	4
Hyannis,	12	Newburyport,	432
Hyde Park,	348	Newton,	374
Ipswich,	12	Hospital,	474
Lawrence,	2,196	North Adams,	299
Lee,	12	North Andover,	54
Leicester,	12	North Attleborough,	24
Lenox,	42	North Brookfield,	3
Leominster,	550	North Reading,	12
Lexington,	120	Northampton,	122

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1906, to Nov. 30, 1907 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Northampton — *Con.*		Stockbridge,	24
Insane Hospital,	10	Stoneham,	169
Northborough,	12	Stoughton,	54
Northbridge,	120	Sunderland,	12
Norton,	4	Sutton,	42
Norwell,	12	Swampscott,	60
Norwood,	60	Taunton,	286
Orange,	12	Templeton,	12
Oxford,	6	Tewksbury,	25
Palmer,	42	State Hospital,	62
Peabody,	336	Topsfield,	7
Petersham,	30	Tyngsborough,	50
Pittsfield,	227	Upton,	12
Plymouth,	202	Uxbridge,	48
Provincetown,	6	Wakefield,	75
Quincy,	649	Wales,	31
Randolph,	72	Walpole,	18
Reading,	421	Waltham,	299
Revere,	257	Hospital,	600
Rockland,	115	Ware,	248
Rockport,	30	Warren,	12
Rowley,	18	Watertown,	84
Salem,	1,224	Webster,	68
Salisbury,	15	Wellesley,	60
Saugus,	387	West Bridgewater,	6
Scituate,	18	West Brookfield,	4
Sharon,	12	West Harwich,	6
Sherborn,	6	West Springfield,	112
Shirley,	42	Westborough,	43
Somerville,	1,300	Westfield,	48
Hospital,	405	Westford,	24
Southampton,	6	Westport,	24
Southbridge,	36	Weymouth,	396
Spencer,	12	Whately,	6
Springfield,	921	Whitman,	75
Sterling,	20	Wilbraham,	12

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1906, to Nov. 30, 1907 — Concluded.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Williamsburg,	12	Woburn,	123
Williamstown,	24	Worcester,	7,721
Wilmington,	6	Worthington,	6
Winchendon,	18	Yarmouth,	6
Winchester,	48	Total,	64,807
Winthrop,	198		

The total number of tubes of vaccine virus issued by the Board during the three years and two months ended Nov. 30, 1907, was as follows: —

	Tubes.
In 1904–1905 (year ended Sept. 30, 1905),	23,970
During fourteen months ended Nov. 30, 1906,	31,805
In 1906–1907 (year ended Nov. 30, 1907),	45,265
Total,	101,040

The vaccine virus was distributed as shown in the following table: —

Number of Tubes of Vaccine distributed from Dec. 1, 1906, to Nov. 30, 1907.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Abington,	79	Boston — *Con.*	
Amesbury,	363	Mt. Sinai Hospital,	55
Andover,	3	Penal Institutions,	2,225
Arlington,	341	St. Elizabeth's Hospital,	85
Attleborough,	185	Braintree,	124
Ayer,	94	Bridgewater,	36
Bedford,	23	Brockton,	6
Belmont: —		Brookline,	587
McLean Hospital,	75	Cambridge,	1,255
Boston: —		Carlisle,	40
City Hospital,	795	Chelmsford,	280
General Supply,	10,831	Chelsea,	1,441
Infants' Hospital,	245	Clinton,	477
Massachusetts General Hospital,	142	Cohasset,	70

Number of Tables of Vaccine distributed from Dec. 1, 1906, to Nov. 30, 1907 — Continued.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Concord,	15	Merrimac,	25
State Reformatory,	800	Methuen,	446
Danvers,	188	Milford,	200
Insane Hospital,	324	Millbury,	42
Dedham,	455	Milton,	170
Duxbury,	61	Needham,	35
East Bridgewater,	3	Newton,	587
Everett,	411	Hospital,	6
Fall River,	2,740	North Adams,	163
Fitchburg,	719	North Andover,	29
Foxborough: —		North Attleborough,	153
State Hospital,	229	Northampton,	57
Georgetown,	135	Norwood,	179
Groton,	22	Orange,	23
Groveland,	225	Oxford,	315
Hingham,	199	Palmer,	333
Holbrook,	66	Massachusetts Hospital for Epileptics.	135
Holden,	32	Pembroke,	5
Hull,	40	Pittsfield,	30
Hyde Park,	167	Plymouth,	13
Lancaster,	20	Quincy,	840
Lawrence,	4,730	Randolph,	53
Lee,	900	Revere,	50
Lenox,	25	Rockland,	185
Lexington,	112	Salem,	172
Lincoln,	10	Sharon,	3
Lowell,	130	Sherborn,	85
Lynn,	760	Somerville,	1,009
Malden,	56	Springfield,	1,270
Mansfield,	45	Stoughton,	40
Marblehead,	74	Taunton,	663
Marshfield,	15	Townsend,	39
Medfield,	72	Wakefield,	273
Medford,	84	Walpole,	60
Medway,	10	Waltham,	251
Melrose,	248	Ware,	38

Number of Tables of Vaccine distributed from Dec. 1, 1906, to Nov. 30, 1907 — Concluded.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Warren,	52	Westford,	40
Watertown,	137	Westminster,	110
Wellesley,	145	Westport,	82
Wenham,	50	Weymouth,	265
West Brookfield,	10	Whitman,	22
West Newbury,	35	Wilmington,	20
Westborough: —		Winchester,	50
Insane Hospital,	150	Worcester,	1,975
Westfield,	166	Total,	45,265

REPORT UPON DIPHTHERIA CULTURES EXAMINED DURING THE YEAR ENDED NOV. 30, 1907.

From Dec. 1, 1906, to Nov. 30, 1907, 4,646 cultures were received from 142 cities and towns in the State. Of these cultures, 2,121 were for the purpose of diagnosis, 2,479 were for release from quarantine and 46 were unclassified or doubtful.

The following table gives the number of cultures received from the different towns and cities and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Abington,	72	12	22	38
Amesbury,	2	1	1	-
Arlington,	79	10	17	52
Athol,	19	2	4	13
Attleborough,	22	8	10	4
Avon,	2	-	2	-
Ayer,	1	-	1	-
Barnstable,	5	4	1	-
Bedford,	4	1	2	1
Belmont,	25	5	5	15
Berlin,	9	2	1	6
Beverly,	170	34	22	114
Bolton,	1	-	1	-
Boston,	7	2	4	1
Boxford,	5	1	-	4
Braintree,	17	2	11	4
Bridgewater,	32	7	5	20
Brockton,	1	-	1	-
Brookfield,	3	1	-	2
Cambridge,	3	-	1	2
Canton,	11	2	4	5
Chelsea,	225	31	42	152

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Cheshire,	2	–	2	–
Chesterfield,	1	–	1	–
Clinton,	43	15	17	11
Cohasset,	13	1	9	3
Concord,	14	2	3	9
Danvers,	124	20	42	62
Dedham,	40	8	22	10
Dennis,	3	1	2	–
Douglas,	12	8	2	2
Dover,	2	2	–	–
Dudley,	3	–	–	3
Duxbury,	3	–	3	–
East Bridgewater,	27	6	5	16
Easton,	25	6	6	13
Everett,	198	26	37	135
Falmouth,	7	1	2	4
Foxborough,	42	5	22	15
Framingham,	13	1	6	6
Gardner,	15	5	8	2
Great Barrington,	12	–	2	10
Groton,	8	2	4	2
Groveland,	1	–	1	–
Halifax,	1	–	1	–
Hamilton,	54	10	11	33
Hanover,	11	2	1	8
Hanson,	2	–	1	1
Hardwick,	35	11	8	16
Harwich,	2	–	2	–
Hingham,	108	16	31	61
Hinsdale,	2	1	1	–
Holbrook,	78	15	21	42
Holliston,	2	–	–	2
Hopkinton,	6	3	3	–
Hubbardston,	3	1	1	1
Hudson,	10	7	3	–
Hull,	10	–	10	–
Huntington,	1	–	1	–
Hyde Park,	154	15	24	115

CITY OR TOWN.	Whole Number of Cultures examined.	CULTURES EXAMINED FOR DIAGNOSIS.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Ipswich,	4	1	3	-
Kingston,	1	-	1	-
Lancaster,	10	-	6	4
Lawrence,	30	8	12	10
Lexington,	5	1	2	2
Littleton,	2	1	1	-
Lynnfield,	1	-	1	-
Malden,	241	28	58	155
Manchester,	33	5	5	23
Mansfield,	41	9	8	24
Marblehead,	97	18	39	40
Marlborough,	40	7	19	14
Marshfield,	14	1	6	7
Medfield,	9	2	5	2
Medford,	207	39	80	88
Melrose,	138	21	39	78
Methuen,	4	2	1	1
Middleborough,	1	-	1	-
Middleton,	5	1	2	2
Millis,	14	4	8	2
Milton,	131	19	44	68
Natick,	25	5	16	4
Needham,	18	9	5	4
Newburyport,	32	11	16	5
Norfolk,	2	-	2	-
North Adams,	76	16	7	53
North Andover,	1	-	1	-
North Attleborough,	2	-	1	1
North Reading,	3	-	3	-
Norwood,	11	3	6	2
Oak Bluffs,	1	-	-	1
Peabody,	61	11	14	36
Pembroke,	3	1	1	1
Pepperell,	11	1	2	8
Petersham,	3	-	1	2
Pittsfield,	2	2	-	-
Plymouth,	4	-	3	1
Princeton,	2	-	2	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Quincy,	49	11	30	8
Randolph,	11	3	6	2
Reading,	139	27	19	93
Rehoboth,	1	–	1	–
Revere,	116	15	45	56
Rockland,	70	9	32	29
Rockport,	7	1	5	1
Rowley,	1	–	1	–
Salem,	245	17	29	199
Saugus,	119	15	37	67
Scituate,	7	–	7	–
Sharon,	14	1	2	11
Sherborn,	1	–	1	–
Shirley,	38	4	20	14
Southbridge,	19	1	2	16
Stockbridge,	5	–	1	4
Stoneham,	77	16	16	45
Sturbridge,	6	–	–	6
Stoughton,	42	11	24	7
Sutton,	12	6	3	3
Swampscott,	34	5	7	22
Taunton,	13	4	9	–
Templeton,	2	–	1	1
Uxbridge,	1	–	1	–
Wakefield,	28	5	12	11
Wales,	1	–	1	–
Walpole,	29	6	7	16
Ware,	1	–	1	–
Warren,	5	1	2	2
Watertown,	97	16	24	57
Wellesley,	22	5	12	5
Westborough,	16	6	6	4
Westfield,	10	1	3	6
West Stockbridge,	2	–	–	2
Westport,	1	1	–	–
Westwood,	1	1	–	–
Weymouth,	28	5	19	4
Whitman,	12	–	4	8

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Wilmington,	3	–	3	–
Winchendon,	56	6	6	44
Winchester,	49	7	31	11
Winthrop,	88	10	17	61
Woburn,	26	8	11	7
Wrentham,	9	2	3	4
	4,600	767	1,354	2,479
Unclassified and cases reported as "doubtful,"	46	–	–	–
Total,	4,646	–	–	–

REPORT UPON THE EXAMINATION OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

From Dec. 1, 1906, to Nov. 30, 1907, microscopical examination has been made of 1,705 lots of sputum and other material suspected of containing the bacilli of tuberculosis. This material has been received from 154 different cities and towns in the State. The following table gives the places from which the material has been received and the results of the microscopical examination: —

City or Town.	Whole Number of Examinations.	Positive.	Negative.	Doubtful.	City or Town.	Whole Number of Examinations.	Positive.	Negative.	Doubtful.
Abington, . . .	8	1	7	–	Cambridge, . .	2	–	2	–
Acton, . . .	2	1	1	–	Canton, . . .	1	–	1	–
Adams, . . .	12	5	7	–	Chelsea, . . .	24	2	20	2
Amesbury, . . .	2	–	2	–	Clinton, . . .	6	2	4	–
Andover, . . .	2	1	1	–	Cohasset, . . .	1	–	1	–
Arlington, . . .	20	5	14	1	Concord, . . .	3	–	3	–
Ashland, . . .	9	1	8	–	Concord, Massachusetts Reformatory.	11	5	6	–
Attleborough, . .	9	2	7	–	Danvers, . . .	40	4	36	–
Avon, ...	4	1	3	–	Dedham, . . .	11	3	8	–
Ayer, ...	1	–	1	–	Dover, . . .	2	2	–	–
Barnstable, . .	3	1	2	–	Duxbury, . . .	1	1	–	–
Belmont, . . .	2	1	1	–	East Bridgewater, .	2	2	–	–
Beverly, . . .	15	4	10	1	Essex, . . .	1	1	–	–
Blackstone, . .	10	3	7	–	Everett, . . .	65	15	50	–
Boston, . . .	11	1	10	–	Fall River, . . .	228	87	137	4
Braintree, . . .	17	5	12	–	Foxborough, . .	12	3	9	–
Brewster, . . .	1	–	1	–	Framingham, . .	10	5	5	–
Bridgewater, . .	3	2	1	–	Franklin, . . .	2	1	1	–
Brockton, . . .	3	–	3	–	Gardner, . . .	13	4	9	–

City or Town.	Whole Number of Examinations.	Positive.	Negative.	Doubtful.
Gill,	3	–	3	–
Gloucester,	7	1	6	–
Great Barrington,	4	2	2	–
Greenfield,	10	1	9	–
Hadley,	2	1	1	–
Hampden,	2	1	1	–
Hamilton,	2	–	2	–
Hanover,	2	–	2	–
Hanson,	4	2	2	–
Haverhill,	4	2	2	–
Hingham,	18	6	12	–
Holbrook,	8	2	6	–
Holden,	7	1	6	–
Hopkinton,	3	1	2	–
Hudson,	2	–	2	–
Hull,	4	–	4	–
Hyde Park,	43	11	31	1
Ipswich,	9	2	7	–
Lancaster,	1	1	–	–
Lawrence,	75	23	49	3
Lexington,	17	3	14	–
Littleton,	2	1	1	–
Lynn,	6	1	5	–
Lynnfield,	2	–	2	–
Malden,	48	25	23	–
Manchester,	8	2	6	–
Mansfield,	13	–	13	–
Marlborough,	22	2	20	–
Marshfield,	2	2	–	–
Maynard,	6	–	6	–
Medford,	50	18	31	1
Medfield,	2	1	1	–
Melrose,	41	11	30	–
Methuen,	7	2	5	–
Middleborough,	6	1	5	–
Middlefield,	1	–	1	–
Middleton,	1	–	1	–
Milford,	12	6	6	–
Millis,	1	1	–	–
Milton,	10	1	9	–
Montague,	3	–	3	–
Natick,	20	7	12	1
Needham,	9	3	6	–
New Bedford,	1	–	1	–
Newburyport,	1	–	1	–
Newton,	2	1	1	–
North Adams,	77	25	49	3
North Andover,	1	–	1	–
North Attleborough,	12	5	7	–
North Brookfield,	2	–	2	–
Northfield,	1	–	1	–
Norton,	8	2	6	–
Norwell,	1	–	1	–
Norwood,	12	3	9	–
Oxford,	3	3	–	–
Palmer,	3	2	1	–
Peabody,	25	10	15	–
Pembroke,	2	–	2	–
Pittsfield,	4	1	3	–
Plymouth,	7	2	5	–
Quincy,	41	11	30	–
Randolph,	7	2	5	–
Raynham,	2	2	–	–
Reading,	18	1	17	–
Revere,	14	4	10	–
Rockland,	18	2	16	–
Rockport,	4	1	3	–
Salem,	37	15	22	–
Saugus,	11	2	9	–
Savoy,	1	–	1	–
Scituate,	1	–	1	–
Sharon,	5	1	4	–
Sheffield,	1	–	1	–
Shelburne,	1	–	1	–

City or Town.	Whole Number of Examinations.	Positive.	Negative.	Doubtful.	City or Town.	Whole Number of Examinations.	Positive.	Negative.	Doubtful.
Sherborn, . . .	11	6	5	–	Watertown, . .	7	1	5	1
Shirley, . . .	4	1	3	–	Wayland, . . .	3	1	2	–
Somerset, . . .	6	2	4	–	Wellesley, . . .	13	1	12	–
Somerville, . .	6	3	3	–	Wellfleet, . . .	1	–	1	–
Southborough, . .	4	1	3	–	Wenham, . . .	1	–	1	–
Southbridge, . .	1	–	1	–	West Brookfield, .	5	2	3	–
Spencer, . . .	4	3	1	–	Westfield, . . .	19	6	12	1
Stoneham, . . .	1	1	–	–	Westford, . . .	5	2	3	–
Sutton, . . .	1	–	1	–	Westminster, . .	1	–	1	–
Swampscott, . .	1	–	1	–	Westport, . . .	1	–	1	–
Swansea, . . .	3	–	3	–	Weymouth, . .	25	11	14	–
Taunton, . . .	58	11	46	1	Whitman, . . .	10	4	6	–
Tewksbury, . .	1	1	–	–	Wilbraham, . .	1	1	–	–
Topsfield, . . .	1	–	1	–	Williamstown, . .	4	1	3	–
Townsend, . . .	2	–	2	–	Wilmington, . .	13	4	9	–
Upton, . . .	1	–	1	–	Winchendon, . .	1	–	1	–
Wakefield, . . .	6	1	4	1	Winchester, . .	16	5	10	1
Waltham, . . .	1	1	–	–	Winthrop, . . .	18	5	13	–
Walpole, . . .	22	3	19	–	Woburn, . . .	19	4	15	–
Ware, ...	12	5	7	–	Wrentham, . .	3	1	1	1
Warren, . . .	2	1	1	–	Total, . . .	1,705	499	1,183	23

TYPHOID FEVER.

WIDAL, AGGLUTINATIVE OR SERUM TEST.

During the year ended Nov. 30, 1907, the Widal test was carried out with 705 specimens of blood. In one instance the result was not decisive. Of the 704 cases in which the result of test was definite, 140, or 19.8 per cent., gave a positive reaction. Specimens were sent in from 94 cities or towns. These facts are shown in detail in Table I. In a second table (Table II.) the specimens, positive and negative, are classified according to the day of the disease on which they were collected. A moderate number of second and third specimens from the same case were examined, so that the total number of tests made is somewhat over the number of cases of disease concerned. The methods used during the year were the same as those previously in use in the laboratory, and they have been amply described in the reports of the year 1900 and the years following.

TABLE I. — *Widal Test, Dec. 1, 1906, to Nov. 30, 1907, inclusive, classified according to the City or Town from which the Specimen was sent.*

CITY OR TOWN.	Number of Cases.	Positive.	Negative.	CITY OR TOWN.	Number of Cases.	Positive.	Negative.
Abington,	15	6	9	Hamilton,	1	1	–
Adams,	2	–	2	Hanson,	2	–	2
Andover,	2	–	2	Haverhill,	3	–	3
Arlington,	22	2	20	Hingham,	5	–	5
Attleborough,	7	2	5	Holden,	1	1	–
Ayer,	3	–	3	Hopkinton,	2	1	1
Belchertown,	1	1	–	Hull,	14	3	11
Belmont,	16	–	16	Hyde Park,	7	3	4
Beverly,	13	3	10	Lancaster,	1	–	1
Boxford,	1	–	1	Lawrence,	12	4	8
Brookline,	1	–	1	Lexington,	2	1	1
Cambridge,	18	3	15	Littleton,	1	–	1
Canton,	6	1	5	Lynn,	105	32	73
Chelmsford,	1	–	1	Malden,	6	2	4
Chelsea,	8	–	8	Manchester,	1	–	1
Concord,	5	–	5	Marlborough,	11	5	6
Danvers,	9	1	8	Medford,	23	3	20
Dartmouth,	1	–	1	Medway,	6	–	6
Dedham,	6	1	5	Melrose,	9	–	9
Dennis,	1	–	1	Middleton,	5	1	4
Dighton,	1	–	1	Milford,	9	2	7
Duxbury,	4	1	3	Milton,	6	2	4
Easton,	2	–	2	Natick,	45	10	35
Everett,	20	3	17	Needham,	14	1	13
Falmouth,	1	–	1	Newburyport,	29	5	24
Gardner,	2	–	2	Newton,	1	–	1
Gloucester,	2	1	1	North Adams,	7	1	6
Groton,	1	–	1	North Attleborough,	1	1	–

TABLE I. — *Widal Test, Dec. 1, 1906, to Nov. 30, 1907, inclusive* — Concluded.

CITY OR TOWN.	Number of Cases.	Positive.	Negative.	CITY OR TOWN.	Number of Cases.	Positive.	Negative.
North Reading, .	1	–	1	Taunton, . .	12	4	8
Northampton,	5	–	5	Tisbury, . . .	2	2	–
Northfield, . .	2	–	2	Topsfield, . . .	3	–	3
Norton, . . .	2	–	2	Wakefield, . .	4	1	3
Norwood, . .	5	1	4	Walpole, . . .	5	–	5
Oak Bluffs, . .	1	–	1	Wayland, . .	1	–	1
Peabody, . .	7	1	6	Wellesley, . .	21	1	20
Quincy, . . .	13	1	12	Westfield, . .	3	–	3
Reading, . . .	12	2	10	Westford, . .	14	4	10
Revere, . . .	8	3	5	Westport, . .	2	–	2
Rockland, . .	8	1	7	Weymouth, . .	2	–	2
Rockport, . .	3	–	3	Whitman, . .	2	–	2
Salem, . . .	6	1	5	Williamstown, .	7	–	7
Salisbury, . .	1	–	1	Winchester, . .	11	1	10
Saugus, . . .	3	1	2	Winthrop, . .	7	3	4
Scituate, . . .	2	–	2	Woburn, . . .	2	–	2
Sharon, . . .	1	1	–				
Sherborn, . .	1	–	1		704	140	564
Somerset, . .	11	6	5				
Somerville, . .	1	–	1	Cases reported as "doubtful," .	1	–	–
Stoughton, . .	3	–	3				
Swampscott, . .	10	2	8	Total, . .	705	–	–

TABLE II. — *Widal Test, according to Stage of Disease, Dec. 1, 1906, to Nov. 30, 1907, inclusive.*

APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.		APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.	
	Positive.	Negative.		Positive.	Negative.
1, ...	–	7	25, ...	2	5
2, ...	–	5	26, ...	1	3
3, ...	1	8	27, ...	1	2
4, ...	4	19	28, ...	–	3
5, ...	6	29	29, ...	1	1
6, ...	1	20	30, ...	1	2
7, ...	8	51	31, ...	1	1
8, ...	9	29	32, ...	–	2
9, ...	8	23	34, ...	1	3
10, ...	7	34	35, ...	–	2
11, ...	2	23	36, ...	–	2
12, ...	6	23	38, ...	–	1
13, ...	4	11	39, ...	–	1
14, ...	17	34	41, ...	–	1
15, ...	–	6	43, ...	–	1
16, ...	4	8	44, ...	1	2
17, ...	5	7	45, ...	1	1
18, ...	3	6	49, ...	–	1
19, ...	3	4	65, ...	1	–
20, ...	4	6	82, ...	–	1
21, ...	3	17	113, ...	–	1
22, ...	–	4	Not stated, ...	33	150
23, ...	1	3			
24, ...	–	1	Total, ...	140	564

MALARIA.

From Dec. 1, 1906, to Nov. 30, 1907, 33 blood specimens were received to be examined for the presence or absence of the malarial parasite. Of these, 5 were positive, 26 negative, and in 1 instance the preparations were so badly made that the examinations could not be completed. The percentage of positive cases was 16.1. The following table shows the city or town from which the specimens, positive and negative, were derived: —

City or Town.	Number of Cases.	Positive.	Negative.
Boston,	5	2	3
Chelsea,	1	-	1
Dedham,	1	-	1
Hingham,	4	-	4
Hull,	4	1	3
Melrose,	1	-	1
Milton,	2	-	2
Newton,	3	-	3
Norwood,	1	-	1
Quincy,	1	-	1
Rockport,	1	1	-
Saugus,	1	-	1
Walpole,	2	-	2
Wellesley,	1	1	-
Winchester,	3	-	3
Total,	31	5	26

A RECORD

OF THE

PROCEEDINGS AND OBSERVATIONS OF THE STATE INSPECTORS OF HEALTH.

BY THE ASSISTANT TO THE SECRETARY OF THE BOARD.

A RECORD OF THE PROCEEDINGS AND OBSERVATIONS OF THE STATE INSPECTORS OF HEALTH.

The following report, in accordance with the provisions of chapter 537 of the Acts of 1907, covers the work of the State Inspectors of Health for the fifteen weeks ended Oct. 31, 1907, which date concludes the fiscal year established by that act.

HEALTH DISTRICT NO. 1.

CHARLES E. MORSE, M.D., *Wareham, State Inspector of Health.*

Description of District.

This district includes the counties of Barnstable, Dukes and Nantucket, and the town of Wareham.

The Work in General.

Most of the time has been devoted to the examination of factories and minors in factories, and to the collection of data relative to the health of towns, with particular reference to the prevalence of tuberculosis.

Factory Inspection.

Sanitary Condition of Factories. — The factories inspected were, as a rule, in fairly good sanitary condition. They were well lighted, well ventilated and not crowded. In some factories in which emery wheels injurious to the health of employees are used, such wheels were found in operation unfurnished with hoods for the protection of employees against dust. Dry grindstones were observed to give rise to considerable dust with ordinary use, and when "turned down" to create an excessive amount.

Examination of Minors. — About 100 minors were examined, and with but few exceptions were found to be in good health. Moreover, a careful examination of the exceptions failed to show any localized or systemic disease.

First-aid Outfits. — It was noted that most factories visited were supplied with medical and surgical appliances, in accordance with chapter 164 of the Acts of 1907, for the immediate treatment of injured persons. One establishment was found to have very commendable provisions, including an operating room with an operating table, instruments, dressings, splints and other supplies, besides a room with two beds, and a toilet and bath apartment. A physician makes daily visits for the treatment of accidents.

Health of Towns.

Prevalence of Tuberculosis. — As nearly as could be determined by corresponding with local boards of health and physicians, there were found to be about 40 cases of consumption in an advanced stage, in the district (population, 37,972). Many of these cases were observed to be wholly ignorant of the means of protecting members of the family and the public from the disease. Moreover, others, owing to financial circumstances, were found to be lacking the attention and care which their condition demanded.

Outbreaks of Contagious Diseases. — There has been no outbreak of contagious or infectious disease within the district during the period covered by this report.

Work on Wearing Apparel.

Only one house was discovered where clothing is made under section 56, chapter 106 of the Revised Laws.

HEALTH DISTRICT NO. 2.

ADAM S. MACKNIGHT, M.D., *Fall River, State Inspector of Health.*

Description of District.

This district includes the cities of Fall River and New Bedford, and the towns of Acushnet, Berkley, Dartmouth, Dighton, Fairhaven, Freetown, Marion, Mattapoisett, Rehoboth, Rochester, Seekonk, Somerset, Swansea and Westport.

The Work in General.

Much time was spent in making a study of the district. Information was obtained concerning the prevalence of diseases dangerous to the public health, particularly typhoid fever, in several localities. Two months after the passage of the act to establish health districts the State Inspector of Health of this district issued his first communication to the boards of health of the various cities and towns within the district, bringing to their notice, especially, that part of the act which calls for co-operation on the part of the local authority, the State Inspector of Health and the State Board of Health as regards the methods to be used in eradicating diseases which are dangerous to the public health. Unsanitary conditions in the yards, barns and out-buildings of tenement blocks in various parts of Fall River were called to the attention of the local health authority. A few manufacturing establishments were visited.

Factory Inspection.

The Spitting Habit. — It was observed that weavers, especially loom fixers, were very prone to spit, and that the use of tobacco was largely responsible for the habit. Since no provision was made until this year to require receptacles for spitting, employees have been accustomed to spit on the floors, including the area about machinery, and upon the machinery itself. In some of the mills visited, anti-spitting notices were observed. One mill submitted the following notice to the inspector for approval: "Do not spit on the floor. To do so may spread disease." The company later furnished these notices, and posted them in all parts of the mill.

Water Supply for Humidifiers. — In some establishments humidifiers were found to be supplied with river water, into which the sewage enters from various mills; and, since it is customary to use water over and over again for humidifying purposes, the water was unusually foul, emitting a very disagreeable odor.

HEALTH DISTRICT No. 3.

WALLACE C. KEITH, M.D., *Brockton, State Inspector of Health.*

Description of District.

This district includes Plymouth County, exclusive of the towns of Marion, Mattapoisett, Rochester and Wareham, and, in addition, the towns of Cohasset and Weymouth.

The Work in General.

Visits were made to nearly all the towns in the district, for the purpose of meeting local health authorities and making a study of general conditions. The following subjects were considered: inspection of factories; examination of minors in factories; negligence in reporting tuberculosis cases; local nuisances; unsanitary railroad stations; ventilation of schoolhouses; outbreaks of contagious diseases.

Factory Inspection.

Sanitary Condition of Factories. — Of the 25 factories inspected, the sanitary conditions were found to be satisfactory in 10. As a rule, the owners of the factories readily complied with whatever suggestions or orders were deemed necessary to improve the conditions.

Examination of Minors. — Of the minors examined, none were found in ill health.

Health of Towns.

Laxity in reporting Tuberculosis. — In conferences with local health authorities, considerable stress was laid upon the need of requiring physicians to report all cases of tuberculosis.

Local Nuisances. — Nuisances were reported to the health authorities of Plymouth, West Bridgewater, Whitman and Brockton, and in most instances were abated.

Unsanitary Railroad Stations. — Unsanitary conditions were observed to exist in and about five railroad stations: Montello, Brockton, Campello, Whitman and Plymouth. The facts were called to the attention of the vice-president of the railroad, who agreed to have the conditions remedied.

Ventilation of Schoolhouses. — A room used for school purposes in the town hall in Hanson was found to be improperly ventilated. An order was issued requiring an improvement in ventilation, and was complied with within thirty days.

Outbreaks of Contagious Diseases. — Small outbreaks of contagious diseases were investigated, — 6 cases of scarlet fever in Hingham and 6 cases of diphtheria in Rockland.

HEALTH DISTRICT NO. 4.

ELLIOTT WASHBURN, M.D., *Taunton, State Inspector of Health.*

Description of District.

This district includes the cities of Quincy and Taunton, and the towns of Attleborough, Avon, Bellingham, Blackstone, Braintree, Canton, Dedham, Easton, Foxborough, Franklin, Holbrook, Hyde Park, Mansfield, Milton, Norfolk, Norton, North Attleborough, Norwood, Plainville, Randolph, Raynham, Sharon, Stoughton, Walpole, Westwood and Wrentham.

The Work in General.

A letter was sent to the board of health of every city and town in the district, quoting in full the act to establish health districts and to appoint State Inspectors of Health, and emphasizing the need of co-operation and good will between the boards of health and the State Inspectors of Health. With one exception, written assurances of co-operation were received. Consultations were held with several boards of health, with whom it was decided to hold regular meetings in the future.

Factory Inspection.

List of Factories in District. — A list of all the factories in the district was compiled. A number of incomplete examinations were made for instructive purposes.

Health of Towns.

Outbreaks of Contagious Diseases. — During the time covered by the report there occurred no unusual amount of contagious disease in any part of the district. Several boards of health agreed to notify the State Inspector of Health whenever any disease became prevalent to an unusual degree, and all boards of health were requested to do likewise.

Advice to a Local Board of Health. — The following information was sent to the Attleborough board of health, in accordance with a request from that board for advice as to the measures to take regarding milk producers who fail to make the sanitary improvements suggested by the State Board of Health, viz., that "to bring about an improvement in the manner of keeping, storing and delivering milk and in the manner of housing and caring for cows and milking the same, it would first be necessary for their board to pass such regulations covering these points as they should deem necessary for the preservation of the public health; that said regulations should not be unreasonable, and would after proper publication have all the force of law;

and that then the board could proceed to order the necessary changes and could enforce the same, which they could not at present do in the absence of such specific regulations. Copies of such regulations from several cities were left with the board for guidance."

HEALTH DISTRICT No. 5.

HARRY LINENTHAL, M.D., *Roxbury, State Inspector of Health.*

Description of District.

This district includes Suffolk County.

The Work in General.

Most of the time was spent in investigating conditions in dwelling houses where work is done on wearing apparel, and in issuing licenses for such work. During the period covered by the report 512 licenses were granted, 32 refused and 17 revoked.

Tenement-house Work.

The work on wearing apparel in dwelling houses was found to be carried on entirely by women, and to consist of crocheting ladies' undervests, making children's garments, nightgowns and aprons, finishing trousers and making buttonholes.

Types of Dwellings and Sanitary Conditions. — A study of the conditions observed led to the division of these dwellings into three distinct classes, as follows: —

Class I. Single-family houses or large flats, — comfortable.

Class II. Moderately large flats in tenements for two or three families.

Class III. Flats with two or three rooms in the large tenement houses.

Of Class I., many were found situated in Chelsea, Revere and other suburbs of Boston. The work was mainly crocheting on ladies' undervests. The sanitary conditions were satisfactory, and the only reason for inspection appeared to be for the purpose of guarding the public health against the spread of contagious diseases.

The dwellings of Class II. were found scattered throughout the district. The work was mainly on children's garments and white goods. The sanitary conditions were, in the main, reasonably good.

In the dwellings of Class III. the work consisted chiefly of finishing trousers and making buttonholes. This work was found to be done almost entirely by Italian women, who were helping support large families. These dwellings were overcrowded, poorly ventilated, with dark halls, often with unclean water-closets, and with bedrooms with windows opening into narrow, dirty alleys, into air shafts, or without windows. There were no bath rooms. Almost invariably the kitchen was used as a dining room and living room. It was in the kitchen that most of the work on wearing apparel was done, and, as a rule, this room was clean and well lighted. Very rarely a sitting room was found in addition to the kitchen and bedrooms. This class of dwellings would appear to require frequent inspection, in order to maintain such sanitary conditions as are compatible with public health.

Standard of Cleanliness in Licensed Workrooms. — Careful investigation showed the standard of cleanliness of the licensed flats to be far higher than that prevailing in similar dwellings in the neighborhood where persons were not at work on clothing. This information is instructive, in view of the fact that it is necessary to maintain a certain standard of cleanliness in order to hold a license.

Diseases Dangerous to the Public Health.

Unreported Diseases. — Diseases dangerous to the public health may, and undoubtedly do, occur in tenement-house workrooms, and run their course without being reported. A physician may not have been called in, and the case remains unreported; or the physician may fail to do his duty.

Motives for concealing tuberculosis were discovered to be carried to the extent of falsifying death certificates. One striking instance of such falsification was noted in the following way: while inspecting a tenement house occupied by a number of Italian families who were holding licenses, a young person was found in the last stage of pulmonary tuberculosis. All licenses were revoked. Several days later, after the patient's death, inquiry at the office of the local board of health relative to the disinfection of the premises showed that the case had not been reported. Further inquiry, however, revealed the fact that the death certificate gave the diagnosis of "broncho-alveolitis."

In several suspicious cases, applicants for licenses underwent, by permission, a physical examination. Seven persons were discovered with an active tubercular process, and the licenses were revoked.

Contagious Diseases reported to Local Authorities. — By co-operation on the part of the local health authorities and the use of a card index, the existence of reported contagious disease in a licensed dwelling is readily discovered, and the spread of the disease by wearing apparel guarded against.

Examination of Minors.

A boy was found in a dark, unventilated basement of a mercantile establishment, suffering with tuberculosis and heart disease. His father was notified, and it was learned later that the boy gave up his position.

Suggestions made by the State Inspector of Health.

The following suggestions were carried out: —

(1) Blank forms were sent to 22 private sanatoria for tubercular patients, in Massachusetts, for notification of admittance, in order that the State Inspector of Health might be kept informed of patients with tuberculosis, and might notify the local boards of health within his district of the necessity of fumigating the premises vacated by said patients.

(2) Letters were sent to hospitals by the Boston board of health, requesting to be informed of every change in address of tubercular patients.

(3) The local boards of health within this district have disinfected all rooms which were called to their attention by the State Inspector of Health.

Notes from the Diary of the State Inspector of Health.

Oct. 1, 1907. — "I have the feeling that in many of the tenements the rooms are occupied by a greater number of inmates than represented. It seems to be a common practice among Italians to have lodgers, where every available space is utilized for sleeping purposes."

Oct. 5, 1907. — "Have observed that sickness among the Italians is often permitted to go on for a long time before a doctor is sent for. A contagious disease may thus run its course unattended, not reported, and the work on wearing apparel will continue."

Oct. 17, 1907. — "If dressmaking is done in a house where people live, licenses should be required and places should be inspected. The mere fact that the customer visits the place herself does not protect the community against the spread of disease from such places. Section 56, chapter 106, Revised Laws, should be amended to include this class of dwelling houses."

Oct. 25, 1907. — "It came to my attention that manufacturers of neckties give out work without licenses."

Nov. 15, 1907. — "When a license is revoked, the employer is notified. The woman, under the pretext that she lost the license, may refuse to return it. She can then go to another employer, and there is nothing to prevent her from getting work, and she can continue to work indefinitely. The strict enforcing of monthly reports from employers may help conditions somewhat."

Health District No. 6.

Albert P. Norris, M.D., *Cambridge, State Inspector of Health.*

Description of District.

This district includes the cities of Cambridge, Everett, Malden, Medford, Melrose and Somerville, and the towns of North Reading, Reading, Stoneham and Wakefield.

The Work in General.

Much time was spent in granting and refusing licenses to persons working on wearing apparel in tenement houses.

Information was obtained relative to the spread of contagious diseases, and suggestions were made to several boards of health concerning the abatement of local nuisances.

Tenement-house Work.

Three hundred and ninety-two licenses were granted, and 5 refused, to persons working on clothing in tenements and dwellings.

The work on clothing in this district was observed to be chiefly crocheting necks of ladies' underwear and sewing seams in men's and women's clothing. It was found to be done generally in the family sitting room, which in most cases is the dining room, the kitchen in three-room tenements, and a separate room in the best homes. The degree of cleanliness in these homes was, as a rule, very good; only in a few cases were dirty places found.

Contagious Diseases in Tenement Workrooms. — Several persons with arrested tuberculosis were found working upon goods, but in no instance was a person with an active tubercular process discovered.

In one instance an unscrupulous dealer was found trying to traffic in a quarantined home. His goods were seized and fumigated.

The larger clothing establishments were found to have facilities for sterilizing by steam all goods returned from homes quarantined with contagious cases.

Death from Contagious Disease in Tenement Workroom. — The Stoneham board of health, on being notified of a death from a contagious disease in a house where clothing was made, caused the rooms to be thoroughly aired and fumigated.

Local Nuisances.

The following nuisances were abated by local health authorities upon the suggestion of the State Inspector of Health: —

(1) Privy vault overflowing. (Abated by Wakefield board of health.)

(2) Inadequate disposal of sink water and a very imperfectly constructed privy. (Abated by Stoneham board of health.)

(3) Unsanitary privy. (Abated by Stoneham board of health.)

Diseases Dangerous to the Public Health.

Contagious Diseases. Suggestions to Local Health Authorities. — Advised Everett board of health as to the management of a suspected case of smallpox.

Reported 3 cases of typhoid fever on two contiguous farms in North Reading, which pointed to direct infection.

Reported 8 cases of diphtheria in Stoneham. Advised the local health authority to require two consecutive negative cultures before releasing a diphtheria patient.

Laxity in reporting Tuberculosis. — Conferences were held with the boards of health of Wakefield, Stoneham, Malden and Somerville, relative to the need of more complete returns of cases of tuberculosis.

Ventilation of Schoolhouses.

Inadequate ventilation of the Centre School, Malden, was called to the attention of the superintendent of schools, with a request that proper provisions be made.

HEALTH DISTRICT NO. 7.

J. WILLIAM VOSS, M.D., *Beverly, State Inspector of Health.*

Description of District.

This district includes the cities of Beverly, Gloucester, Lynn and Salem, and the towns of Danvers, Essex, Ipswich, Hamilton, Lynnfield, Manchester, Marblehead, Middleton, Nahant, Peabody, Rockport, Saugus, Swampscott, Topsfield and Wenham.

The Work in General.

The greater part of the time was spent in examining factories and tenement-house workshops. The sanitation of schoolhouses was considered, and a number of nuisances were called to the attention of local boards of health.

Inspection of Factories.

Many factories were inspected. In some of them conditions were ideal.

A Model Establishment. — In one large establishment men were employed to keep the water-closets and cuspidors in proper condition; a well-equipped hospital was furnished for first-aid work; and a restaurant was provided, where food could be bought at a reasonable price. The water supply was found to be unsatisfactory, and, at the suggestion of the State Inspector of Health, a good supply was substituted.

Hospital for the Injured. — In another large establishment the sanitary conditions varied with the age of the buildings from fair to excellent. Following the suggestion of the State Inspector of Health, a hospital for first aid to the injured was established.

Conditions in Shoe Factories. — Spitting was observed in most of the factories, but receptacles for spitting were seldom found. Denatured alcohol was found to be generally displacing wood alcohol.

The sanitary condition of water-closets was bad. Following are the words of the State Inspector of Health: " Most of the water-closets are badly located in the center of the room, where ventilation and lighting are necessarily inadequate. The effluvia from them are sure to pollute the air of the rooms. One seldom sees a urinal in these factories. Even the new buildings are having the closets arranged in the same old way."

Tenement-house Workshops.

Two hundred and forty licenses were issued to persons working on clothing in tenements and dwellings.

Sanitation of Schoolhouses.

All the schoolhouses in Peabody and Salem were inspected. The sanitary conditions in many of the schools in Peabody were found to be far from satisfactory, and below modern requirements. The sanitary conditions in most of the Salem schools were found to be good, although some untidiness was observed in many buildings.

Local Nuisances.

Written Communications to Boards of Health. — On August 15 the Hamilton board of health was informed of the following unsanitary conditions at Asbury Grove: (1) foul-smelling privies, and excreta exposed to flies; (2) a stagnant ditch, unsightly and foul smelling, into which bedroom slops were thrown. The local authority agreed to require some improvement to be made before the opening of another season.

On August 20 the Beverly board of health was notified that a number of factories were not provided with cuspidors, and that a first-aid outfit had not been observed in any factory visited. The local authority, through an advertisement in the newspapers, notified all the factories of the law requiring an outfit for injured persons.

On August 24 the Beverly board of health was notified regarding an unsanitary system of plumbing in a factory. The local inspector of plumbing pronounced the plumbing faulty, and ordered changes.

On September 7 the Gloucester board of health was informed of unsanitary conditions near the junction of Leonard and Curve streets. The nuisance was abated.

On October 24 the Lynn and Saugus health authorities were informed of a dead fish nuisance in the Saugus River district. The matter was attended to by the local authorities, and the nuisance abated.

HEALTH DISTRICT NO. 8.

WM. HALL COON, M.D., *Lawrence, State Inspector of Health.*

Description of District.

This district includes the cities of Haverhill, Lawrence and Newburyport, and the towns of Amesbury, Andover, Boxford, Georgetown, Groveland, Merrimac, Methuen, Newbury, North Andover, Rowley, Salisbury and West Newbury.

Work in General.

In addition to inspecting a large number of factories and investigating numerous local nuisances, suggestions were made to local health authorities as follows: (1) to the Groveland board of health, relative to quarantining cases of smallpox; (2) to the Lawrence board of health, relative to the establishment of a bacteriological laboratory; (3) to the Amesbury board of health, relative to the enforcement of quarantine in cases of measles; (4) to the Salisbury and Groveland boards of health, relative to the release from quarantine of scarlet fever patients; (5) to all boards of health within the district relative to reporting cases of contagious diseases.

Factory Inspection.

During the period covered by this report 100 factories were visited.

Water-closets. — In by far the largest proportion of the factories visited the water-closets were found to be dirty, and in many instances unventilated. Of the 87 shoe factories visited, changes were ordered in 68.

Seats for Women. — In accordance with the provisions of section 41, chapter 106 of the Revised Laws, a sufficient number of seats were ordered for the women employees in three textile mills.

Local Nuisances.

Following the suggestions made to the Lawrence board of health to clean and to keep clean the alley running between Newbury and Jackson streets, Lawrence, and the alley, yards and dividing areas about the block surrounded by Common, Essex, Newbury and Union streets, said localities were promptly cleaned and have since been kept clean.

On August 6 the attention of the Newburyport board of health was called to unsanitary sewage conditions existing on the premises of four families on Water Street. A drain belonging to one of the houses was ordered repaired, and sewer connection was made with two of the others. No action was taken relative to the fourth.

On August 12 the attention of the Salisbury board of health was called to the lack of proper water and sewage facilities for Salisbury beach. At the lower end of the beach three water-closets, three cesspools, two sink drains emptying on the ground, and two wells used for drinking purposes, were found within a radius of thirty feet. Up to the present time (November 1) no action has been taken by the local health authority.

A local drainage nuisance on Huntington Avenue, Amesbury, was called to the attention of the Amesbury board of health on August 28, and later abated by that board.

On September 9 unsanitary conditions about a well in Amesbury, from which water was supplied for drinking purposes to the factory of F. S. Merrill & Co., were reported to the State Board of Health.[1]

Contagious Diseases.

Smallpox. — Aid was given the board of health of Groveland in controlling an outbreak of smallpox which was first recognized on August 1. Twenty-eight cases occurred in a small area, which was kept in strict quarantine. The following suggestions of the State Inspector of Health were adopted by the local health authority: —

(1) Strict quarantine of the infected houses.

(2) Compulsory vaccination of the inhabitants in South Groveland and Groveland proper.

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[1] The results of the analysis of the water are stated in another portion of the annual report.

(3) Compulsory vaccination of the employees in the Groveland Woolen Mills. During July and August 1,200 persons were vaccinated.

Measles. — On finding that during the eight months preceding August there had been 100 cases of measles in Amesbury, and that the local board of health was not enforcing quarantine, it was recommended to said board that strict quarantine regulations should be made and enforced, and placards posted whenever any case of measles occurred. In spite of the suggestion by the State Inspector of Health, the local health authority neither quarantined nor placarded cases of measles.

Scarlet Fever Quarantine. — On recommendation of the State Inspector of Health, the Salisbury and Groveland boards of health have required, since September, an isolation period of three weeks in cases of scarlet fever.

HEALTH DISTRICT NO. 9.

CHARLES E. SIMPSON, M.D., *Lowell, State Inspector of Health.*

Description of District.

This district includes the cities of Lowell and Woburn, and the towns of Acton, Arlington, Ayer, Bedford, Billerica, Boxborough, Burlington, Carlisle, Chelmsford, Concord, Dracut, Dunstable, Groton, Harvard, Lexington, Lincoln, Littleton, Maynard, Pepperell, Shirley, Stow, Tewksbury, Townsend, Tyngsborough, Westford, Wilmington and Winchester.

The Work in General.

Much time was taken for matters relating to tenement-house work.

Various health questions were considered with the health officials of the cities and of most of the towns in the district.

The few factories visited were among the best.

Tenement-house Work.

Forty-one licenses were granted to persons working on wearing apparel.

A case of scarlet fever was discovered in a dwelling where clothing was made. The following boards of health were requested to report every known case of contagious disease in a dwelling where work is done on wearing apparel: Woburn, Lexington, Winchester and Arlington. Each family working on wearing apparel, and each employer, was asked to report immediately any such disease.

Health of Towns.

Contagious Diseases. — It was discovered that local health authorities have neglected to inform each other of cases of contagious diseases in dwellings in which pupils live, who attend school in other towns.

Some evidence was obtained to the effect that physicians who come from out of town to attend children sick with contagious diseases are not as careful to report to the proper health authority as when they live in the same town with the patients.

Improper Quarantine. — Nine days after a local board of health fumigated the premises where a child had been ill with scarlet fever, the child's hands were found desquamating. During this interval the child attended a public school. The child was again isolated, and the board of health promised to adopt a more rigid system of quarantine in the future.

In another town a scarlet fever patient, supposed to be quarantined, was observed riding in a street car.

Schools and Quarantine. — It was found that the Lowell schools will not receive a pupil who has been quarantined with a contagious disease without a permit from the board of health. The same is true of the Woburn schools and the Woburn board of health.

Fumigation. — All the boards of health cause houses which have been placarded on account of cases of diphtheria, measles and scarlet fever to be fumigated after recovery or death of the patient.

The Lowell board of health fumigates after the removal or death of a person who has been ill with tuberculosis only when requested by the family or landlord.

Bacteriological Laboratories and Diphtheria Cultures. — Lowell has a well-equipped laboratory, where bacteriological examinations are made for Lowell physicians regardless of the patients' dwelling places, and for all Lowell patients regardless of the physicians' residences. The bacteriologist is allowed to make examinations for surrounding towns at a reasonable charge per specimen. The following towns have work done at the Lowell laboratory: Dracut, Tewksbury (usually), Billerica, Chelmsford, Tyngsborough, Westford (occasionally) and Littleton (rarely). Most of the neighboring towns use the laboratory for diagnosing diphtheria, but few for releasing the patient from quarantine.

The Lowell board of health have agreed to notify the town, in addition to notifying the patient's physician, as was formerly the custom, whenever a positive diphtheria culture is obtained for diagnosis.

The following towns require release cultures in cases of diphtheria: Billerica (always), Tyngsborough (always) and Tewksbury (in some cases).

Inspection of Factories.

Factory inspection was confined to a few of the best establishments, for the purpose of becoming familiar with the highest standards. The following subjects received some attention: —

(1) The best places to post drinking-water notices.

(2) The best places to post anti-spitting notices.

(3) Some method of detecting cases of sickness among the employees, especially tuberculosis.

Sanitary Provisions in Schoolhouses.

In accordance with an order for better sanitary provisions in an old school building in Lincoln, the privies were materially improved.

HEALTH DISTRICT NO. 10.

WILLIAM W. WALCOTT, M.D., *Natick, State Inspector of Health.*

Description of District.

This district includes the cities of Marlborough, Newton and Waltham, and the towns of Ashland, Belmont, Brookline, Dover, Framingham, Grafton, Holliston, Hopedale, Hopkinton, Hudson, Medfield, Medway, Mendon, Milford, Millis, Natick, Needham, Northborough, Sherborn, Shrewsbury, Southborough, Sudbury, Upton, Watertown, Wayland, Wellesley, Westborough and Weston.

Work in General.

An attempt was made to determine the conditions existing in and about all the factories within the district. No orders were issued, except in cases where distinctly unfavorable conditions were found to obtain. While a few such establishments were in evidence, there were more with model conditions.

The total number of factories and workshops visited was 231. The industries most frequently met with were found to be as follows: textiles, 36; machinery, machine parts and metal supplies, 33; shoes, 32.

Of the 36 textile mills visited, the sanitary conditions in 4 were found to be very satisfactory; in 23, reasonably good; in 6, moderately bad; and in 3, distinctly bad. Although it was observed that the rooms in mills were not overcrowded, as they are commonly found to be in shoe factories, it was noticed that but comparatively few of the employees in old, low-storied rooms could obtain the benefit of the light from windows. Many of the mills were found to be provided with blower systems or other mechanical means for the purpose of improving ventilation and removing dust or other impurities. In one room, in a mill of moderate size, 24 women were said to threaten to strike unless the exhaust fans were stopped, on the ground that they preferred the excessive heat, foul air and dust to the danger of catching cold. Several mills had no hygrometers, and in many mills where these instruments were provided but little use was made of them. In a spinning room in one mill where the steam vapor pot system was installed, the foreman said that he could regulate the humidity of a room better by the "feel and taste of the air" than by the use of hygrometers.

In the establishments used for the manufacturing of machinery, machine parts and metal supplies, the sanitary conditions of greatest importance were relative to the processes of dry grinding, buffing and polishing. With few exceptions it was found that the employees were properly protected against dust. The rooms were not overcrowded, and the light and ventilation in general were good. The men engaged in the work were apparently in the best physical condition. The foundries, as a rule, were reasonably well ventilated, in spite of the fact that the men were, to some extent, exposed to smoke, dust, metal and acid fumes and extreme heat.

Of the 32 shoe factories visited, the sanitary conditions in 4 were found to be very satisfactory; in 14, reasonably good; in 8, moderately bad; in 6, distinctly bad. With very few exceptions the employees were found working in well-lighted rooms. In the old buildings the work was done near the windows, while in the modern factories the benches which were placed some distance from the windows were observed to be generally well lighted. In both old and new factories the stitching room was very frequently found to be overcrowded.

Comparatively few minors were observed in the shoe factories. Their physical condition appeared, in the main, to be good. The most unhealthy and poorly nourished people were among the Hungarians and Polanders. Investigation of their homes, markets, provision stores and other places showed that they lived in overcrowded and unsanitary buildings. They were underfed. Careful investigation disclosed the fact that Americans, Irish, Germans and French Canadians, working in the same factories, under the same conditions and for the same wages, were healthy and well nourished.

The employers, managers and superintendents were, as a rule, willing to do their part towards maintaining proper sanitary conditions, and it was found that the conditions in the establishments throughout the district were, in the main, favorable. Many of the managers asked for suggestions, on the ground that it was more for their own interest than for the interest of the State to have their employees work under favorable conditions.

Model Establishments and Model Tenements. — In one community both model workshops and model tenements were provided for the employees. Recently a new bath room for the foundry workers was constructed.

Spittoons must be kept Clean. — In one factory a spittoon was furnished each employee, who, in turn, was obliged to keep the spittoon clean. Any man detected in the act of spitting on the floor was required to clean up after himself at once.

In a shoe factory a spittoon was furnished for every two men. The spittoons were cleaned daily by a man employed for that purpose.

Signs prohibiting Spitting. — Signs prohibiting spitting were noted in nearly all the factories within the district.

A Lunch Counter. — In one of the shoe factories, on the top floor, a lunch counter was provided, where, for a moderate price, coffee, eggs and sandwiches could be obtained.

A Reading Room. — In one factory a reading room was provided, so that those who brought their dinners might eat and read during the noon hour.

Exhaust Fans for Metal Dust. — One of the machine shops was provided with an unusually effective system for the removal of metal dust. In the buffing and polishing room the air was practically free from dust. The belts were run under the floor.

In another establishment the hoods were so constructed that a minimum of dust escaped. For some automatic, self-feeding machines, where the grinder travelled a few inches, the hood was so arranged that it travelled, too, and thus always covered the grinder. Even some wet grinders were provided with hoods.

Washrooms and Sinks. — One large factory was found provided with individual wash basins in long sinks. In most factories, however, several employees might be seen to wash at once in the same water; while in some factories one or two basins supplied the need in turn.

A Distinctly Bad Factory. — One old, four-storied, brick mill was dark, low-storied, with dirty walls and dirty windows. The rooms were overcrowded, and the air was so impure and dusty as to be injurious to the health of the persons employed therein. The water-closets were dirty, and emptied directly into a river. This was the only factory found with thoroughly bad sanitary conditions.

Factories with Commendable Sanitary Conditions. — Eighteen factories were found to present, in the main, satisfactory hygienic conditions.

Good Sanitary Conditions in Old Buildings. — One establishment illustrated the fact that old buildings, even with low-storied rooms, may be kept well ventilated and free from dust, and that the water-closets therein may be clean and well cared for.

Individual Bath Room in Foundry. — One of the foundries was provided with a large bath room, with cement floor, so constructed that each man had a bath room with hot and cold water and a locker for his clothes.

River Pollution by Factories. — Twenty-three factories were found to pollute either the Assabet or the Charles River with sewage, wash water, dye liquors, dilute acids, leather dust, etc.

Relation between Sickness and Factory Conditions. — An attempt was made to determine in each factory visited the amount of time lost from sickness, and the relation between the illness in question and the conditions under which an employee was working. While it was impossible, with the data at hand, to obtain reliable information, some general facts are worth recording: (1) All the factory managers agreed that with few exceptions they were unable to discover whether loss of time was due to sickness, excesses, or merely to an indisposition to work, the latter being by no means uncommon, especially among skilled workmen who feel assured that they will not be discharged for taking an occasional day off. (2) There was found to be a direct relation between pay day and the loss of time, — that more men were absent on the day following pay day and on Monday, than at other times. (3) During the warm weather it was noted that malaria was responsible for many absences of the employees in the factories along the Charles River, in Newton, and to a less extent in the Waltham factories. Surrounding many of these factories were caves, swamps, shallow brooks, pools and other good breeding places for mosquitoes.

Tenement-house Work. — A few licenses were granted to persons working on clothing in tenements and dwellings.

Diphtheria Outbreak. — Five cases of diphtheria were investigated in Millis.

HEALTH DISTRICT NO. 11.

MELVIN G. OVERLOCK, M.D., *Worcester, State Inspector of Health.*

Description of District.

This district includes the city of Worcester, and the towns of Auburn, Brookfield, Charlton, Douglas, Dudley, Leicester, Millbury, Northbridge, North Brookfield, Oxford, Southbridge, Spencer, Sturbridge, Sutton, Uxbridge, Warren, Webster and West Brookfield.

The Work in General.

Every town in the district was visited. The following subjects were considered: inspection of factories; tenement-house work; local nuisances; contagious diseases.

Factory Inspection.

Sanitary Conditions. — Of the 22 factories inspected, the sanitary conditions in 14 were found to be satisfactory, while in 8 establishments conditions were found which were not in accordance with the statutes.

A Model Establishment. — In one factory, employing 1,000 women, the following comforts were provided, in addition to maintaining a high standard of ventilation, cleanliness and lighting, viz.: (*a*) individual lockers; (*b*) large dining room; (*c*) well-equipped emergency room on each floor.

First-aid Outfits. — The law relative to keeping medical and surgical appliances in factories was found to be complied with in all of the 22 establishments visited.

Examination of Minors. — During the period covered by this report no minor was found whose condition, in the opinion of the State Inspector of Health, called for a physical examination.

Tenement-house Work.

Forty-four licenses were issued to persons working on clothing in tenements and dwellings. In one instance a license was refused.

A list of tenement houses in which persons work on clothing was furnished the Worcester board of health, which, in turn, agreed to notify the State Inspector of Health of all contagious diseases known to exist in said houses.

Local Nuisances.

The unsanitary condition of many of the yards in the rear of buildings was brought to the attention of the Worcester board of health, from which board the following reply was received: —

We have asked the co-operation of the police in regard to these conditions, and will again speak to the chief of police about it. One thing which seriously handicaps us is that Worcester, unlike any other city of its size that we know of, has no public ash collection service. This we have recommended annually to the city council for several years.

Health of Towns.

Contagious Diseases. — Because of the continued prevalence of diphtheria in the city of Worcester, the suggestion was made to the local health authority that cultures be taken from the throats of all members of a household before a patient is released from quarantine or the placard is removed. To this request the board of health made the following reply: —

> This matter was thoroughly discussed by the board more than six months ago, but it was found to be impracticable to do this, and was therefore abandoned.

HEALTH DISTRICT NO. 12.

LEWIS FISH, M.D., *Fitchburg, State Inspector of Health.*

Description of District.

This district includes the city of Fitchburg, and the towns of Ashburnham, Ashby, Athol, Barre, Berlin, Bolton, Boylston, Clinton, Dana, Gardner, Hardwick, Holden, Hubbardston, Lancaster, Leominster, Lunenburg, New Braintree, Oakham, Paxton, Petersham, Phillipston, Princeton, Royalston, Rutland, Sterling, Templeton, Westminster, Winchendon and West Boylston.

Work in General.

Of the 29 towns within the district, 21 were visited for the purpose of obtaining information relative to health matters.

Thirty-five factories were inspected. Comments were made on the ventilation of 11 schoolhouses.

Several small outbreaks of contagious diseases were investigated.

Factory Inspection.

The hygienic conditions in the 35 factories visited were found to be very good in 3, good in 10, fair in 15 and poor in 7.

Ventilation of Schoolhouses.

Four schoolhouses in Bolton and one in Gilbertville were found to be poorly ventilated. Other schoolhouses visited were: one in Ashby, one in Barre, one in Boylston, one in North Lancaster and two in Gilbertville, all of which were found to be adequately ventilated, and in good sanitary condition.

Contagious Diseases.

The following cases of contagious diseases were investigated, and found in every instance to be well quarantined: —

Twelve to 15 cases of diphtheria in Winchendon during the summer.

Six cases of diphtheria in Templeton in August and September.

Several cases of scarlet fever in Gardner in September.

Three cases of typhoid fever in Fitchburg in September.

Two cases of typhoid fever in Princeton in September.

Warning to the Public. — Red flags are displayed in order to call public notice to infected places in the following towns: Berlin, Bolton, New Braintree, Oakham, Phillipston, and Royalston.

Printed instructions relative to infectious or contagious diseases are furnished by the boards of health of Clinton, Leominster and Fitchburg.

Quarantine Regulations. — The boards of health in the following places try to enforce strict quarantine: Athol, Clinton, Fitchburg, Leominster and Winchendon.

The following towns are lax in enforcing quarantine: Berlin, Bolton, Hardwick, New Braintree, Paxton and Royalston.

Fumigation. — Fumigation is left with the attending physician in the following towns: Berlin, Bolton, Hubbardston, New Braintree, Oakham, Paxton, Phillipston and Royalston.

Cultures in Diphtheria Suspects. — The following towns send to Clinton for culture tubes: Berlin, Bolton and Lancaster.

When Fitchburg physicians attend cases in Ashby and Lunenburg, they sometimes depend on their city for cultures. Hardwick sends to Springfield.

HEALTH DISTRICT NO. 13.

HARVEY T. SHORES, M.D., *Northampton, State Inspector of Health.*

Description of District.

This district includes all of Franklin County, and all of Hampshire County excepting the towns of Huntington, Middlefield and Worthington.

Outline of Work.

The information obtained relative to health conditions in this district has been arranged in connection with each city and town as follows: —

Amherst. — Four factories were found in the village. In one of these factories the sanitary conditions were very satisfactory. In another factory the sanitary conditions were satisfactory. Four minors were found to be in good health. In another small factory, in which no minors were employed, good sanitary conditions obtained. The other factory was crowded. One female employee was found to have tuberculosis; her physician was notified, and forbade her working.

Ashfield. — Six small woodworking factories were inspected, none of which was provided with a first-aid outfit.

Buckland. — There was found to be no sewerage or water system in town, and some very bad conditions were noted.

Charlemont. — A consultation was held with the board of selectmen relative to the fumigation of dwellings, the abatement of nuisances, the provision requiring emergency outfits, the report and care of consumptives, and various other health problems.

There was found to be one manufacturing establishment in the town, in which spools and other small wooden articles were made. The sanitary conditions were good; the nature of the work, however, gave rise to much dust.

Chesterfield. — The chairman of the board of health was advised relative to the abatement of a nuisance. It was found that some 8 or 10 cases of typhoid fever occurred in the fall, although the origin of the disease could not be ascertained.

In West Chesterfield four small factories manufacturing wooden articles were visited. In each instance it was necessary to request that more care be taken as to cleanliness.

Colrain. — A large tenement block was found with privies over a water ditch. It was asserted that the odor was very offensive at times when the water was low. A water system was introduced in the town, but the supply of water has proved insufficient for its use in water-closets.

The sanitary conditions in one mill were found to be very good; in another, moderately bad; and in another, distinctly bad. All three factories were equipped with a first-aid outfit.

Conway. — The sanitary conditions in two establishments visited were found to be moderately bad.

Deerfield. — On September 24 the Centre School building was inspected, and three rooms found to be improperly ventilated. An order was issued to the committee appointed to investigate the present conditions of said school building, requiring the rooms to be ventilated in such a manner that the air contained therein shall not become so impure as to be injurious to health. The single manufacturing establishment was inspected, and found to be in good sanitary condition.

Easthampton. — A good water and sewerage system was found to be provided.

Enfield. — The manufacturing establishments comprised two woolen mills and a box factory. The sanitary conditions in the mills were distinctly bad, although the operatives appeared to be in good health.

Erving. — The only manufacturing establishment in the place was found to be clean and well ventilated.

Greenfield. — Three manufacturing establishments were visited, in two of which no minors were employed. All the establishments were in reasonably good sanitary condition.

Hatfield. — A very severe epidemic of scarlet fever has been prevalent among the Polanders for over a year. Malaria has not been so prevalent as in former years. The two factories in the town were inspected. No minors were employed in either. In one building some of the emery wheels and emery belts were found uncovered. In both establishments the water-closet conditions were unsatisfactory.

Montague. — One section of this town, Turners Falls, was found to be in a decidedly unsanitary state. Several hundred filthy privies were discovered. In spite of the fact that a good water and sewerage system has been provided, it was found that there were many streets where not a single house was connected with the sewer. Acting on the suggestion of the State Inspector of Health, the local board of health gave notice in the paper that every house must be connected with the sewer within thirty days. The time expired, however, without any action being taken.

Of the seven factories visited, the conditions in three were satisfactory. In one factory spitting was absolutely prohibited. In another factory, in which 10 minors were employed, 2 boys, each fourteen years of age, were discovered without school certificates. The cutlery factory visited employed about 500 persons, 100 of whom were women and minors. The establishment was in a distinctly unsanitary condition. The rooms were not even reasonably clean, and the water-closets were few in number and faulty. The large grinding room was wet. The air in the large grinding room was unduly moist, and the room itself was wet and cold. Where good suction pipes and flues had been provided for the small emery stones, in almost every instance they had been broken. It was alleged that the employees broke the pipes on the ground that they could work faster without them. Many of the minors were examined, and none of them seemed very vigorous.

Northampton. — For a period of two years all cases of consumption have been reported to the local board of health. Every house which an afflicted person has vacated has been fumigated and, in every instance possible, literature bearing upon the disease has been given to the patient. During the last of October the State exhibit on tuberculosis was held here at an expense of $75, borne by the city and the local tuberculosis society. The meetings were well attended, and much enthusiasm was apparent. The local board of health has made it a point to inspect all cases of scarlet fever after the attending physician has reported recovery, and in no instance has a patient been released from quarantine who was found desquamating.

Of the six manufacturing establishments visited three presented very good hygienic conditions. A basket factory, employing about 50 men, all of whom were Polanders, appeared to be in a satisfactory sanitary condition, although most of the men were noticeably thin and poorly nourished. Investigation disclosed the fact that these men were living on very little nourishing food. In another factory, where hoes and shovels were manufactured, while the work itself was dirty, the factory conditions were but moderately bad. The employees, however, appeared to be extremely ill nourished. In a cutlery establishment visited it was found that many of the large grinding stones were being substituted for machines which have a good hood protection against dust. The factory was found to be in a reasonably good condition. A small leather board factory, employing two minors, was in a very dirty condition. Immediate improvement was ordered.

Northfield. — A small outbreak of scarlet fever was investigated.

Pelham. — The single factory was inspected, and found to present reasonably good hygienic conditions.

Shelburne. — Shelburne Falls was found to be provided with a good sewerage and water system.

Shutesbury. — Consultation with the chairman of the selectmen disclosed the fact that but little care or attention was given to health subjects.

Southampton. — Consultation with the chairman of the selectmen revealed the fact that contagious diseases were very carefully investigated, and that all possible precautions relating to the same were taken.

South Hadley. — It was found that there was no sewerage system except for the college. Further investigation showed that the sewer from the college emptied into a little brook by the roadside, and that it often created a nuisance.

Ware. — The board of health has been making a practice of fumigating rooms vacated by tubercular patients.

Four manufacturing establishments were inspected. One was found to be in a particularly cleanly condition. In this factory many women and minors were employed. The majority of the minors were found to be in good health. A few were advised to change their work. One girl was discovered with symptoms of tuberculosis, and has since been under a physician's care. Eight outfits for emergencies were provided in this factory.

Wendell. — Two factories were inspected, neither of which employed a minor. The sanitary conditions in one of the factories were reasonably good. The other factory was unnecessarily dirty, and was ordered cleaned.

Notes on the Work in General.

During the period covered by the report, the health of many minors was observed, and a physical examination made in a large number of cases. In a number of factories no minors were found at work.

While inspecting each factory, special effort was made to consult with superintendents or foremen concerning the health of employees, regardless of age. Assistance was offered in any case of illness, and a request was made to be informed of any symptoms which aroused suspicion of tuberculosis, such as coughing, frequent spitting, marked loss of flesh.

Much interest was shown on the part of the employers in guarding the health of the employees, and almost no opposition was encountered.

The visits with the various boards of health, or with boards of selectmen acting as health authorities, or with the boards which combine the offices of selectmen, boards of health and overseers of the poor, showed conclusively a great need of disseminating knowledge among health authorities, particularly those in the small towns, respecting means and methods of guarding the public health.

HEALTH DISTRICT No. 14.

RICHARD S. BENNER, M.D., *Springfield, State Inspector of Health.*

Description of District.

This district includes all of Hampden County, and, in addition, the towns of Huntington, Middlefield and Worthington.

Outline of Work.

Letters were sent to the local boards of health or selectmen of all the cities and towns in the district, informing them of the appointment and duties of the State Inspectors of Health. Replies were received from most of the cities. Later, several towns were visited and personal interviews held with health officials.

Advice to Local Boards. — Upon the request of the West Springfield board of health, advice was given that board relative to the action to be taken against a physician who failed to report some cases of scarlet fever. The Westfield board of health was advised concerning the care of a woman with advanced tuberculosis, who was partly a town charge.

Inspection of Schoolhouses. — The sanitary conditions of the schoolhouses in Holyoke were found to need improving.

Factory Inspection. — A few of the best factories in Holyoke were examined, in which there was found to be a deficient number of receptacles for spitting.

HEALTH DISTRICT No. 15.

LYMAN A. JONES, M.D., *North Adams, State Inspector of Health.*

Description of District.

This district includes all of Berkshire County.

The Work in General.

All local health authorities in the district were visited, and information gathered along the following lines: —

(1) The manner of procedure when a case of contagious disease is reported.

(2) The prevalence of contagious diseases.

(3) The manner of fumigating, and by whom done.

(4) The enforcement of quarantine, and the conditions under which pupils are permitted to return to school.

(5) The use of diphtheria cultures.
(6) The release of diphtheria patients from quarantine.
(7) The source of water supply and disposal of waste.
(8) The nature of the industries carried on.

Inspection of Factories.

Some 25 manufacturing establishments were visited. The following industries were found to be well represented: woolen, cotton, paper, shoe, cloth printing, electric.

Reasonably good sanitary conditions were found in many of the factories visited, and nearly ideal conditions were found in a few. There was a great lack of cleanliness in water-closets, and in some establishments an insufficient number of closets were provided. The main unsanitary conditions were found in textile establishments and shoe shops.

Boards of Health and Selectmen.

Two cities and 9 towns, with an aggregate population of 81,000, were found to have boards of health, as follows: Adams, Becket, Clarksburg, Great Barrington, Lee, Lenox, North Adams, Pittsfield, Sandisfield, West Stockbridge and Williamstown.

In 21 towns, with an aggregate population of 17,000, the selectmen performed the duties of boards of health, as follows: Alford, Cheshire, Dalton, Egremont, Florida, Hancock, Hinsdale, Lanesborough, Monterey, Mt. Washington, New Ashford, New Marlborough, Otis, Peru, Richmond, Savoy, Sheffield, Stockbridge, Tyringham, Washington and Windsor.

The reports of local health authorities in the following cities and towns within the district were found to contain matters relating to health: Adams, North Adams, Great Barrington and Pittsfield.

Diseases Dangerous to the Public Health.

Local health authorities in the following cities and towns have been notifying the State Inspector of Health of the prevalence of diseases dangerous to the public health: Adams,[1] Becket, Clarksburg, Dalton, Egremont, Great Barrington, Hinsdale, Lenox, Monterey, Mt. Washington, New Marlborough, North Adams,[1] Otis, Pittsfield,[1] Richmond, Savoy, Tyringham, Williamstown and Windsor.

The above towns and cities represent, approximately, 85 per cent. of the population in the district.

Negative Cultures for the Release of Diphtheria Patients. — Local health authorities in the following cities and towns have been requiring one or more negative cultures before releasing diphtheria patients from quarantine: Adams, one negative culture; Great Barrington, two negative cultures; North

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[1] Make weekly returns.

Adams, one negative culture; Pittsfield, two negative cultures on alternate days; Sheffield, one negative culture; Stockbridge, one negative culture.

Following the suggestion of the State Inspector of Health, the towns of Adams and Williamstown decided to require a negative culture for the release of diphtheria patients from quarantine.

Quarantine and Fumigation in Small Towns. — There was found to be no well-established practice regarding quarantine and fumigation.

Outbreaks of Infective Diseases.

Accounts of local outbreaks of infective diseases which have been investigated by State Inspectors of Health are recorded with those investigated by other agents of the Board in another portion of the annual report.

REPORT

UPON THE

INVESTIGATION OF LOCAL OUTBREAKS OF INFECTIVE DISEASES.

REPORT UPON THE INVESTIGATION OF LOCAL OUTBREAKS OF INFECTIVE DISEASES.

Following are accounts of local outbreaks of disease investigated by agents of the Board: —

BONDSVILLE AND BELCHERTOWN.[1]

Investigation by the State Inspectors of Health of Districts Nos. 13 and 14 revealed the following facts: —

Early in November typhoid fever made its appearance in Bondsville, and by the end of the month the number of cases reported was 17. Across the river, in Belchertown, 4 cases were reported.

All of the 21 victims were supplied with milk by the same dealer, C., a resident of Belchertown. C. produced part of his supply, and secured the rest from two other farmers, G. and S. That which came from G. was not delivered at any of the houses where the cases occurred, and hence may be excluded from consideration. That supplied by S. and that produced by C. were mixed, and the mixture was delivered at these and other houses.

It was learned that one of the first cases reported in Belchertown came at the same time as the first cases in Bondsville, namely, the first week in November, and that the victim was one of C.'s children. It was learned, too, that it was the custom in C.'s family to use in the household such milk as was left after each delivery. The child's case and the first cases in Bondsville were coincident, and hence, unless the child had been ill some days without being conscious of it, they could hardly stand in the relation of cause and effect. No other case occurred in C.'s family, and none was reported from the house of S. On inquiry, however, it was brought out that beginning October 7 and until November 13 a son of S. was too sick to work, and complained of "trouble with his stomach" and "weakness." The attending physician did not treat the case as one of typhoid fever. The person who took care of the son attended also to milking the cows and handling the product, 20 quarts of which were delivered daily to C. The premises of S. when visited showed a general condition of filth which is unfortunately not rare, and the person who had acted as nurse and milker showed a corresponding degree of personal uncleanliness. As it seemed not impossible that the real cause of the son's illness had been overlooked, and that the exciting cause of the 21 cases of typhoid fever in Bondsville and Belchertown had resided in his discharges, had been transferred from them to the milk by the hand that emptied the chamber vessel and did the milking, and thus had been distributed to C.'s customers, the son was subjected to the Widal test, which proved beyond doubt that he had had typhoid fever in what is known as the "walking" type.

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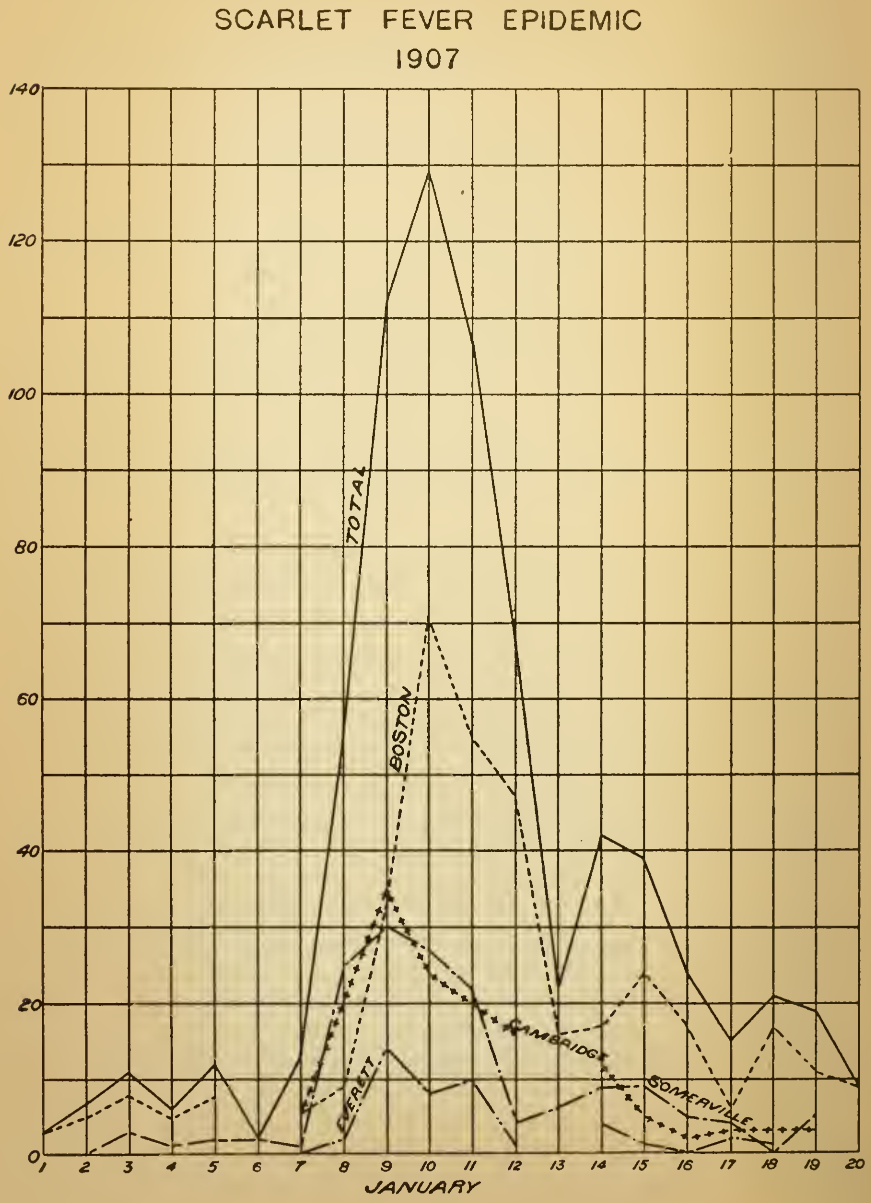
[1] Reported in "Monthly Bulletin," November, 1907.



Boston, Cambridge, Somerville and Everett.[1]

During the first twenty days of January, 1907, 717 cases of scarlet fever occurred in Boston, Cambridge, Somerville and Everett. Of these cases, 367 were in Boston, a number which overtaxed the accommodations for scarlet fever patients at the City Hospital for the first time since its erection; 152 cases occurred in Cambridge, 155 in Somerville and 43 in Everett. Of these cases, 485, or 67 per cent. of the total number, occurred within a period of six days, that is, January 7 to 12, inclusive.

The suddenness of the onset of the epidemic, the fact that the cases were not grouped together in any one locality nor in any one school, and the fact that several cases were reported, such as a mother and her newborn child, a family of children confined with measles, etc., in which ordinary exposure to other scarlet fever cases was impossible, or at least most improbable, immediately suggested a common source of infection. An investigation of the milk supply of the cases showed that one large milk concern supplied families in all four of these cities. A further investigation showed that this dealer supplied in Boston 80 per cent., in Cambridge 85 per cent., in Somerville 86 per cent. and in Everett 83 per cent. of the cases investigated, — an average of 84 per cent. in the four cities. The accompanying diagram shows graphically the course of the epidemic and the interrelation between the cases and the milk supply. Recognizing, accordingly, the relationship between the epidemic and the milk furnished, investigation of the epidemic became an investigation of the business of the concern, which we will designate as "X."

In the first place, the milk business of "X" consists of a large wholesale trade and a retail trade. The cases of scarlet fever were traced back almost without exception to the retail, or bottled milk. Consequently, an investigation of this retail milk was undertaken. The retail milk, that is, the milk which is brought to Boston, bottled at one milk depot, and delivered, for the most part, by "X's" wagons through Somerville, Cambridge, Everett and Boston, comes to Charlestown in two separate cars. One of these cars, Car No. 5, is filled with cans that are gathered by various collectors and loaded upon the cars from six stations, Hollis, Pepperell, Groton, Willows, Graniteville and Westford. The other car, from which the retail milk is obtained, Car No. 9–2, gathers its load from New Braintree, Barre, Coldbrook, West Rutland, Rutland, Jefferson, Muschopauge, Quinapoxet, Oakdale, Berlin and Hudson.

Car No. 5 arrives in Charlestown at 10 o'clock, having put off half of its load at West Somerville. Upon arrival at the milk depot, a large metal vat is placed in the car as it stands on the siding, and this vat is connected by a metal tube with a pipe leading into the depot. The milk is first tasted can by can in the car and then emptied into the vat, whence it flows into a common reservoir in the depot. Then it is pumped over a large cooling apparatus into a strainer, from which it is bottled by machinery and corked. Next the bottles are crated and loaded on the wagons for distribution, or stored in a cold room for later demand, and at 10.15 the milk in Car No. 5 is thus emptied. Car No. 9–2 arrives at Charlestown at 10.20, and at 10.30 the milk is brought therefrom to Car No. 5 and mixed with the milk of the latter.

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[1] Reported in "Monthly Bulletin," March, 1907.

Wagons begin loading for routes in Malden, Somerville, Everett, Revere and Cambridge at 10.30 A.M. From midnight to 7 o'clock the next morning, wagons for routes in Boston and routes in parts of Cambridge and Watertown are loaded.

Infection of the milk is possible: —

First. — At the farms where the milk is produced.

Second. — By the taster of the milk before it is emptied into the vat when the cans are emptied at the milk depot.

Third. — By the milkmen at the depot handling the cans, bottles and apparatus concerned in the process of mixing, cooling, straining and bottling the milk.

Fourth. — By the drivers of the various routes in the process of delivering the milk.

I. *Investigation of the Milk Farms supplying "X."*

Number of farmers supplying milk to cars Nos. 5 and 9–2,		222
Number of farmers interviewed (about),		100
Number of farms inspected,		27
Number of physicians in the district interviewed,		15
Number of cases of scarlet fever investigated: —		
In Pepperell,	12	
In Barre,	4	
	—	16

(1) The possibility of a direct infection of the milk from the 16 cases investigated was not proved.

(2) None of the 16 cases was directly connected with the farms supplying milk.

(3) One farm supplying milk was found to be in a filthy condition, and unqualified to supply clean milk, and not satisfying the conditions advertised by "X" as to the condition of the farms supplying "X" with milk.

(4) The milk cans returned by "X" for use by farmers are not properly cleaned.

(5) The milk cans used in bringing milk to Boston are being used by the farmers for other purposes.

(6) At South Merrimac a farm supplying milk to "X" was found upon which there had occurred three sudden deaths, one on December 31, one on January 1 and the third on January 7. The last case was reported by the attending physician as one of typhoid fever. Milk was shipped from this farm up to January 6, and again on January 16 and 17.

Investigation of these cases showed that they probably were due neither to scarlet fever nor to typhoid fever.

Conclusions. — (1) Milk was supplied to "X" by at least one farmer in violation of the advertised rule that "notice of infectious diseases among the persons concerned in the handling of milk shall be given to the contractors, and the shipment of milk stopped."

(2) A more careful supervision of the farms supplying milk is imperative.

II. *Investigation of the Milk Taster employed at the Milk Depot of "X."*

On January 3 the taster regularly employed by "X" was replaced by a substitute. As this date corresponds closely with that upon which the milk was probably infected, this man and his family were carefully examined. The man showed a tongue with markedly prominent papillæ, back and chest covered with pimples, but no signs of desquamation or other symptoms warranting a diagnosis of scarlet fever. Examination of his family showed that his thirteen-year-old daughter had much enlarged tonsils, a tongue with markedly enlarged papillæ, and signs of a fine scaly desquamation over the lower legs, — signs suggestive, but not diagnostic, of scarlet fever.

Inspection of the method of tasting the milk showed that the milk taster plunged a long spoon into the can to be tasted, lapped the spoon, shook it and plunged it into the next can. The spoon was produced from a dirty pocket, and was plunged into the milk without washing or without rinsing between the lapping of the spoon and immersion into the next can.

Other methods of tasting the milk, such as licking a finger dipped into the can, or licking the plug of the can, were reported, but not observed.

Conclusions. — (1) At a time when infection of the milk distributed by "X" might have caused the epidemic, there was employed at the milk depot of "X" a substitute milk taster whose condition suggested that he had had scarlet fever, and in whose family existed a person with signs strongly suggestive of this disease.

(2) The method of tasting milk, now in use, is exceedingly favorable to infection of the milk if the taster is suffering from contagious disease.

(3) Some cleaner method of testing milk should be utilized, such as the use of destructible throat sticks, in order to avoid infection of the milk by a dirty spoon.

III. Investigation of Workmen employed at the Milk Depot of "X."

On January 14 a physician examined all of the men designated by "X" as engaged in handling the milk in any manner from its arrival on the cars to loading it on the delivery wagons. The throat and tongue, the skin of the chest and arms of each man were examined. Number of men examined, about fifty. Results of the examination: suspicious throats, six.

It appeared that cases of scarlet fever were present in the household of at least two of these employees.

Conclusions. — (1) No cases of scarlet fever among the workmen employed at the depot were found.

(2) Employees were found at work in whose families cases of scarlet fever existed.

(3) A more careful medical inspection of men engaged in the handling of milk is necessary.

IV. Investigation of the Drivers on the Several Milk Routes of "X."

A study of the distribution of the cases of scarlet fever over the various milk routes in Cambridge, Somerville and Everett showed: —

(1) The cases were not limited to one or two routes, but in Everett and Somerville cases occurred on seven of the nine routes, and in Cambridge on seven of the eleven routes.

(2) As nearly as can be ascertained by a rough estimate of the sequence in which the wagons are loaded at the depot, the infected milk left the depot not at any one period, but throughout the day, from 11 o'clock of the morning of the arrival of the milk until 7 o'clock of the next morning.

(3) The routes in charge of the drivers who were either themselves infected, or in whose households cases of scarlet fever developed, showed no greater number of cases than other routes.

(4) The milk routes supplying Cambridge, Somerville and Everett distribute milk on the day of its arrival, while the routes supplying Boston distribute milk early the next morning. In this connection it is to be noted that the epidemic reached its climax one day later in Boston than it did in Cambridge, Somerville and Everett.

Conclusions. — The infection of the milk probably occurred before the sealed jars were loaded upon the wagons for distribution along the various milk routes.

General Conclusions concerning the Epidemic.

(1) The sudden onset of this epidemic, together with its wide distribution, point to a common source of infection.

(2) The simultaneous appearance of the explosion in Cambridge, Somerville, Everett, and, allowing for the fact that the milk distributed in Boston is delivered a day later than it is in the above-mentioned cities, in Boston, suggests that the period of infection was synchronous for these places.

(3) The explosive nature of the outbreak, shown by the fact that 67.66 per cent. of the cases occurred within six days, and the further fact that a large proportion of the stricken persons were taken sick on days during which the same installment of milk was distributed, indicate that the period during which the milk was infected was very brief, — probably one day only.

(4) The fact that in the cases investigated in Boston 80 per cent., in Cambridge 85 per cent., in Somerville 86 per cent. and in Everett 83 per cent. — an average of 84 per cent. — of the persons stricken obtained milk of the same dealer, and had nothing else discoverable in common as a means of infection, justifies the conclusion that the vehicle of contagion was the milk supplied by the dealer " X."

(5) The warm weather prevailing during the first part of January, when the outbreak occurred, was favorable for the multiplication of disease organisms introduced into the milk.

(6) Investigation of the farms supplying milk sold by " X " showed: —

(*a*) That at least one farm is unsanitary, and unfit to produce clean milk.

(*b*) That the milk cans used are not properly cleaned, and that cans are used for purposes other than the bringing of milk to the Boston market.

(*c*) That this dealer is not enforcing his rule, which requires the exclusion of milk from farms on which cases of infectious diseases are reported to exist.

(*d*) That a more careful supervision of the farms supplying milk for public sale is imperative.

(7) From investigation of the employees at the milk depot of " X " it appears: —

(*a*) That certain employees were at work, in whose families there existed cases of scarlet fever.

(*b*) That more careful medical supervision of the men engaged in handling the milk after its arrival should be required of the milk contractors.

(8) From investigation of the methods employed in testing milk at the milk depot it is evident that the least objectionable of those now in use is conducive to infection of the milk.

(9) From investigation of the drivers of the several milk routes it

appears that the milk was probably infected before it was delivered to their hands in the sealed glass bottles in which it is distributed.

(10) A more careful supervision of the methods of milk contractors distributing milk in Boston and its vicinity is imperative; and this supervision should include not only the methods of handling and delivering milk after its arrival in the city, but also the farms from which the milk is obtained.

CAMBRIDGE AND SOMERVILLE.[1]

During the month of September 33 cases of typhoid fever occurred in Somerville and 28 in Cambridge. Investigation by the State Inspector of Health of District No. 6 revealed the following facts. Of the 61 cases, 43, or 70 per cent., occurred within the period September 19–October 1. Of the 33 Somerville victims, 26 were seized in quick succession after September 20, and all of these as well as 1 who came down on September 5, and 6 of the Cambridge victims, obtained milk, directly or indirectly, from the same dealer, who sold part of his night supply to other Cambridge dealers upon whose routes scattered cases of the disease occurred. The first case on this man's route in Cambridge and the first on his route in Somerville appeared at about the same time.

Investigation of the dairies from which the milk supply was derived revealed the fact that to one or more of them were sent cans from a place where milk was bottled and cans were washed by a man who was nursing a person who had been stricken with typhoid fever early in September. He was uncleanly in his habits and very careless in his work, some of the cans which he "washed" being strong-smelling and partially lined with sour scum. It is most likely that infective material from the person whom he nursed was conveyed by his hands directly into the cans and into the milk. This outbreak emphasizes the necessity of strict cleanliness on the part of all who handle milk, and of prohibiting the handling of milk by anybody coming in contact with persons suffering with any of the communicable diseases.

CHESTERFIELD.[1]

About March 1, 1907, Channing Angell and his wife, of Chesterfield, living in an isolated house on the road to the adjoining town of Huntington, were taken suddenly ill. Later, four of their five children were seized with the same symptoms, the only one to escape being a nursing infant. After being treated for about five weeks for what was supposed to be typhoid fever, Mrs. Angell died; whereupon the local board of health appealed to the State Board for the services of an expert to determine the source of the infection. Examination of the other members of the family led to the diagnosis of trichinosis, which finding was abundantly confirmed later. Pieces of salted pork were taken from the food supply on hand and subjected to microscopical examination, which revealed the worms in large numbers.

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[1] Reported in "Monthly Bulletin," October, 1907.

A few days later Mr. Angell succumbed; whereupon post-mortem examinations were made in both cases, and bits of muscular tissue from each body were forwarded to the Board for microscopic study. Four days later one of the children, a girl of three years, died, and her body was examined by order of the district attorney. Each bit of muscular tissue examined in each case contained trichinæ in large numbers. These were most numerous in certain of the preparations made from the tissues of Mr. Angell; and in the tissues of Mrs. Angell and the child many of the organisms were motile.

On May 9 another of the children died, and at the same time it was learned that a neighbor, who had come in to help out when the family was prostrated, was under treatment, but improving rapidly. No post-mortem examination of the body of the fourth victim was made, there being no doubt as to the cause of death.

Inquiry into the circumstances preceding the outbreak revealed the fact that Mr. Angell bought half of a hog which had been killed and dressed in an unlicensed slaughterhouse, and that the carcass was disposed of without any inspection whatever.

The pieces of meat obtained at the house for examination were uncooked, and had recently been salted. It was stated that they were a part of the animal which the family had been eating, and that no other pork had been used.

A communication from the office of the district attorney of the Northwestern District, dated Oct. 9, 1907, states that the person who conducted the slaughterhouse without a license had been convicted and sentenced to pay a fine of one hundred dollars, and that a complaint against the one who sold the meat without the inspection required by law was still pending.

DORCHESTER, MILTON AND HYDE PARK.[1]

On April 13, after a period of comparative freedom from diphtheria, there were reported to the board of health of the town of Milton 11 cases of that disease. This sudden explosion caused, very naturally, a feeling of grave apprehension on the part of the local health authorities, who made immediate application to the State Board of Health for assistance in determining its origin. On the following day another case was reported. Investigation showed that all of the cases reported on April 13 and single cases reported on April 12 and 14 had this in common: that the families of the victims were supplied, without exception, by the same dealer in milk, whose route lies partly in Milton and partly in Dorchester. Inquiry at the office of the board of health of the city of Boston developed the fact that on April 12 there were reported from Dorchester 6 cases; on April 13, 19 cases, and on April 14, 11 cases of the disease, all in families supplied by this same dealer, whom we will designate as "A." Inquiry into the sources of his supply developed the fact that it was derived from six producers, as follows: —

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[1] Reported in "Monthly Bulletin," May, 1907.

J. H., Randolph. — Ten cans, some of which were bought of other producers; all delivered to "A." No diphtheria on the premises of J. H. or on those of the others who contributed to his supply.

R. B. N., Randolph. — Four cans, all sold to "A." No diphtheria.

E. T. T., Randolph. — Three cans, some sold at retail and the rest to "A." No diphtheria on his premises or among his customers.

O. H., Milton. — Seven cans, all sold to "A." No diphtheria.

J. M. B., Milton. — Four or five quarts, all sold to "A." No diphtheria.

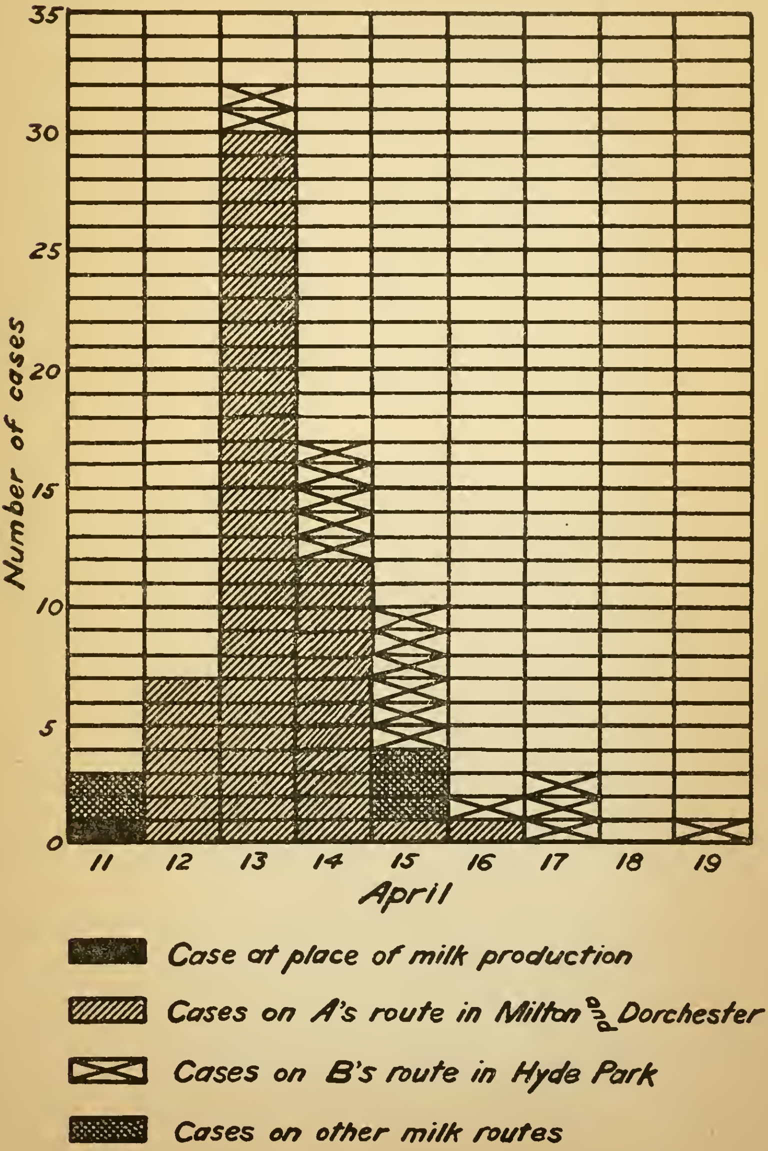
C. F. J., Milton. — Twenty-seven cans, seventeen sold to "A" and ten to a dealer in Hyde Park, whom we will designate as "B."

Inquiry as to the existence of diphtheria on the premises of C. F. J. revealed the fact that his grandchild was seized with the disease on April 11; that the cooler in which the milk was mixed was washed in the house, and that this office was performed by the person who had the care of the sick child.

It appeared probable that herein lay the solution of the problem; but the absence of any reported outbreak in Hyde Park offered an obvious complication, since more than one-third of C. F. J.'s output was delivered to families in that town by dealer "B." On April 14, however, four cases; on April 15, five cases; on April 16, 1 case; on April 17, three cases, and on April 19, 1 case, or fourteen in all, were reported to the board of health of Hyde Park, all of which, and two that had been reported on April 13 without exciting comment, proved to be in families supplied by "B."

Prompt action on the part of the local authorities of Milton in excluding from sale the milk of C. F. J. brought the outbreak to an immediate close. The incidence of the cases is shown by the accompanying diagram. It will be noted that in the three places concerned there occurred, between April 11 and 19, 5 cases among families not supplied by "A" or "B," namely, 2 on April 11 and 3 on April 15. One of the

Outbreak of Diphtheria
in
Milton, Dorchester and Hyde Park.



former was reported in Dorchester, the other in Milton; and the 3 cases reported on April 15 were all in the same household with, and secondary to, the latter.

There were, then, between April 12 and 19, inclusive, in the three places mentioned, 72 cases of the disease, all but 3 of which occurred in families supplied by two dealers, who obtained their milk from a man in whose household a child was seized on April 11; and the 3 cases not connected with this supply were secondary to another case reported on the same day. The fact that the outbreak in Hyde Park occurred later than that in Dorchester and Milton may perhaps be due to the fact that dealer "B" called for his share of C. F. J.'s milk in the evening and sold it on the following day, while dealer "A" came for his in the morning and disposed of it at once.

It is of further interest that C. F. J. himself came down with the disease after the outbreak had nearly subsided, and that dealer "A's" son, who drank milk from C. F. J., was one of the earliest victims. The partner of dealer "B" was seized on April 18, and at about the same time also another member of his household.

Gardner.[1]

During the months of January and February there were a number of scattered cases of scarlet fever (9 in all) in the town of Gardner. In March there was a sudden rise in the number of cases, 46 being reported, 18 of which occurred in the week ended March 7, and 11 during the week ended March 14.

The cases were scattered over the entire town, and were not confined to any one class; but more than half (53.6) of those seized were children between the ages of one and five years.

When the assistance of the State Board of Health was requested in ascertaining the source of the infection and putting an end to the outbreak, the total number of cases had reached (April 17) 69. There were four families with 3 cases each, and sixteen with 2 cases each. Fifty of the cases were primary and 19 were secondary.

The milk supplied to the families in which the cases occurred was distributed by eighteen different dealers, but during the height of the outbreak most of the victims were supplied by one dealer, who distributes about twenty cans of milk daily, which he produces on his own farm, buying none whatever. Part of the milk was delivered at this time in cans and partly in bottles. The bottles, cans, milk pails and other utensils were usually washed by his wife, but those which were returned clean were refilled without further washing. During the month of January, scarlet fever had occurred in four of the families which he supplied, and on February 13 the disease was reported in a family by whom the bottles were returned in so clean a condition that he regarded it unnecessary to cause them to be washed again. On February 19, 2 cases of scarlet fever occurred in his own family, and as soon as the diagnosis was established, his milk room was isolated. He was given a disinfectant bath of a weak solution of corrosive sublimate, and was allowed to continue the distribution of milk, on condition that he should not enter his house. This condition he violated, and, because a number of the families supplied by him became affected, the board of health excluded his milk from public sale early in March.

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[1] Reported in "Monthly Bulletin," May, 1907.

Of the 30 cases which occurred while the epidemic was at its height, 9 were supplied by a contractor who had more than seven hundred customers. His supply was obtained from twenty-five different sources, at none of which could any history of scarlet fever during the preceding six months be obtained.

Of the total number of cases, 24 occurred in school children in eight different schools. The largest number occurring in any one school was 5, and the victims were scattered about in four rooms.

SOMERSET.[1]

During the latter part of September it came to the knowledge of the State Inspector of Health, of District No. 2, that typhoid fever existed in the village of Somerset, and a careful investigation was immediately instituted, which disclosed the fact that 12 persons had been seized between September 8 and 23, and 5 more came down with the disease before the inquiry terminated in October. Of the 17 victims, 7 were children under ten years of age, 2 were housekeepers, 2 were bridge workers, and the others were workmen in various trades.

It was learned that prior to the outbreak, in August and early September, there had occurred among the 30 workmen on the upper and lower bridges of the New York, New Haven & Hartford Railroad, between Somerset and Fall River, frequent cases of illness, marked by headache, nausea, vomiting and diarrhœa, and that at one time about half of the men had left the work on account of sickness. Most of the men boarded in houses scattered throughout the village.

It appeared probable that the initial case of infection among the workmen occurred about the middle of August, and that this man, whose occupation was that of day draw-tender, had the walking type of the disease. Previous to the village outbreak, a resident whose occupation was that of night draw-tender was stricken. The day draw-tender lived in the house of a man who produced milk for public sale, and the night draw-tender was himself a milk producer. It is perhaps more than a mere coincidence that 12 of the 17 village patients were consumers of the milk sold from these two places; but proof that the milk had been specifically contaminated is lacking.

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[1] Reported in "Monthly Bulletin," October, 1907.

Investigation of the water supply at the lower bridge and in various parts of the village showed gross pollution by sewage. During August the bridge workmen used the water of the well at the railroad station, adjoining the premises of the night draw-tender above mentioned. As the water acquired bad odor and taste, its use was discontinued, and then recourse was had to another well between the tracks in front of the station. This well was not protected from surface drainage, and hence it is possible that it may have been polluted by the discharges from the closets of passing trains. The report of the Board on the water supply is given below.

The conditions found on the premises where cases of the disease occurred were in the main exceedingly unsanitary, overflowing cesspools and privy vaults in close proximity to wells being the rule, with barnyards and pigpens in unusually filthy state.

Whether the infection was due to polluted water, or to contaminated milk, or to both, could not be determined.

Following is the report, sent to the local board, on the waters taken for examination: —

To the Board of Health of the Town of Somerset.

Gentlemen: — In response to a communication received Oct. 19, 1907, stating that an epidemic of typhoid fever has occurred in Somerset village, and requesting an examination of the water of certain private wells, the Board has caused an examination to be made of the wells located at the houses of Nicholas Powers, Eber Ray, Sarah A. Hood, Franklin Simmons, George H. Melvin, and of a well located near the New York, New Haven & Hartford Railroad at the foot of Old Colony Avenue, known as the "railroad" well, and samples of their waters to be analyzed.

The results of the analyses show that the water entering all of these wells has been very badly polluted by sewage, and not thoroughly purified in its passage through the ground before entering the wells. The numbers of bacteria were high in the waters of most of the wells, and in some of them bacteria characteristic of sewage were found to be present.

In the opinion of the Board, the further use of the waters of any of these wells, with the exception of that near the house of Franklin Simmons, should be prevented. The water of the well of Franklin Simmons, though badly polluted, was evidently, at the time this examination was made, being quite well purified in its passage through the ground before entering the well, and in its present condition may not be unsafe for drinking; but changes in the circumstances affecting its pollution may at any time render this water unsafe, and the Board cannot recommend its continued use.

The results of the examinations show that there is very great need of a general water supply in this village, and the Board would recommend that the town take measures without delay to introduce a public water supply from some suitable source.

GENERAL HEALTH OF THE STATE IN 1906.

GENERAL HEALTH OF THE STATE IN 1906.

The number of deaths in the State in 1906 was 50,624, which was equivalent to a death-rate of 16.63 per 1,000 upon an estimated population of 3,044,998.

The mean death-rate of the five years 1902, 1903, 1904, 1905 and 1906 was 16.33, as compared with 17.60 for the previous five years.

The following figures are presented for the ten years ended with 1906: —

Massachusetts.

YEARS.	Population.[1]	Deaths.	Death-rates.	YEARS.	Population.[1]	Deaths.	Death-rates.
1897, . . .	2,618,051	47,419	18.11	1902, . . .	2,937,600	47,491	16.17
1898, . . .	2,679,049	46,761	17.46	1903, . . .	3,006,040	49,054	16.32
1899, . . .	2,741,470	47,710	17.40	1904, . . .	3,076,083	48,482	15.76
1900, . . .	2,805,346	51,156	18.24	1905, . . .	3,003,680	50,486	16.81
1901, . . .	2,870,710	48,275	16.82	1906, . . .	3,044,998	50,624	16.63

[1] Population estimated for intercensal years.

INFECTIVE DISEASES.

The death-rate from the principal infective diseases in 1906 varied but slightly from that of 1905. There was an increase in the number of deaths from diphtheria, scarlet fever, measles, whooping cough and cancer, and a decrease in the deaths from consumption, typhoid fever, cholera infantum, dysentery and cerebro-spinal meningitis. The number of deaths from pneumonia was practically the same as in 1905. There were no deaths from smallpox.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

Deaths and Death-rates from Certain Diseases in Massachusetts, 1902–1906.

	1902.		1903.		1904.		1905.		1906.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Smallpox,	284	.97	22	.07	9	.03	2	.007	-	-
Diphtheria,	873	2.97	869	2.89	699	2.27	652	2.17	743	2.44
Scarlet fever,	313	1.07	510	1.70	138	.45	117	0.39	135	0.44
Typhoid fever,	538	1.83	527	1.75	463	1.51	520	1.73	477	1.57
Measles,	333	1.13	247	.82	160	.52	177	0.59	208	0.68
Cholera infantum,	3,157	10.75	2,469	8.21	2,297	7.47	2,617	8.72	2,525	8.29
Consumption,	4,685	15.95	4,531	15.07	4,874	15.84	4,702	15.67	4,608	15.14
Dysentery,	193	.66	188	.63	184	.60	182	.60	176	0.58
Whooping cough,	337	1.15	519	1.73	117	.38	218	.73	509	1.67
Pneumonia,	4,583	15.60	5,190	17.27	5,100	16.58	5,378	17.93	5,377	17.65
Cancer,	2,141	7.29	2,243	7.46	2,421	7.87	2,501	8.33	2,603	8.55
Cerebro-spinal meningitis,	165	.56	156	.52	165	.54	560	1.87	368	1.21

In the following table a balance is presented between the deaths from the principal infective diseases in the two years 1905 and 1906, by which it appears that the sum of the deaths from these twelve causes in 1906 was higher by 103 than those of 1905 from the same causes: —

Deaths from Certain Infective Diseases in 1905 and 1906.

DISEASES.	1905.	1906.	Increase.	Decrease.
Smallpox,	2	-	-	2
Diphtheria and croup,	652	743	91	-
Scarlet fever,	117	135	18	-
Typhoid fever,	520	477	-	43
Measles,	177	208	31	-
Cholera infantum,	2,617	2,525	-	92
Consumption,	4,702	4,608	-	94
Dysentery,	182	176	-	6
Whooping cough,	218	509	291	-
Pneumonia,	5,378	5,377	-	1
Cancer,	2,501	2,603	102	-
Cerebro-spinal meningitis,	560	368	-	192
Totals,	17,626	17,729	533	430

INFANT MORTALITY.

The rate of infant mortality during the year 1906 was somewhat higher than that which prevailed during the five years 1901, 1902, 1903, 1904 and 1905, it being 144.7 for the year 1906, as compared with 141.4 for 1905, 133.6 for 1904, 139.5 for 1903, 140.4 for 1902 and 137.2 for 1901.

The total number of births which occurred during the year ended June 30, 1906, was 76,730, and the total deaths under one during the year ended Dec. 31, 1906, were 11,106.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1896, and June 30, 1897, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1906.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1897, 1898, etc. The births during these ten years were 733,887, and the deaths under one year were 105,708, which is equivalent to an infant mortality-rate of 144.0 per 1,000 births for the decade. The last half of the period shows a gain over the first half, since the infantile death-rate in the last five years was 139.9 per 1,000 births, as compared with 148.2 in the first five years.

Infant Mortality, Massachusetts: 1897–1906, Ten Years.

YEARS.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.	YEARS.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.
1897, . .	72,578	10,751	148.1	1902, . .	71,770	10,075	140.4
1898, . .	73,868	11,012	149.1	1903, . .	73,618	10,269	139.5
1899, . .	71,156	10,532	148.0	1904, . .	74,791	9,992	133.6
1900, . .	72,430	11,500	159.0	1905, . .	74,387	10,519	141.4
1901, . .	72,559	9,952	137.2	1906, . .	76,730	11,106	144.7

Total births in ten years ended June 30, 1906, 733,887.
Total deaths under one in ten years ended Dec. 31, 1906, 105,708.
Mean infantile death-rate, 144.0 per 1,000 births.

SMALLPOX.

During the year 1906 there were 42 cases of smallpox reported to this Board. Of this number, 19 cases were those of males and 23 were of females, with no deaths. In 1905 the fatality from this disease was 4.5 per cent., 9 per cent. in 1904 and 3.3 in 1903. The fatality in 1902, when the epidemic of 1901–03 was at its height, was 11.9 per cent.

In the six years 1901–06, 3,686 cases had been reported to the State Board of Health, with 405 deaths, making a fatality of 11.0 per cent. In 1899 there were 105 cases reported, with 14 deaths, and in 1900 104 cases, with 3 deaths; the fatality for these years being, respectively, 13.3 per cent. and 2.9 per cent.

In 1906 the largest number of cases occurred during the month of June, 19 being reported for that month. Only 1 case each was reported in February and September, and none during the months of January, April, August, October, November and December.

The following table shows the prevalence of the disease by months during the year 1906: —

	Cases.	Deaths.		Cases.	Deaths.
January, ...	-	-	July, ...	10	-
February, ...	1	-	August, ...	-	-
March, ...	5	-	September, ...	1	-
April, ...	-	-	October, ...	-	-
May, ...	6	-	November, ...	-	-
June, ...	19	-	December, ...	-	-

Of the 42 cases reported to the Board, the largest number, 18, occurred in New Bedford. The following table shows the distribution of this disease among the cities and towns of the State: —

	Reported Cases.	Deaths.		Reported Cases.	Deaths.
New Bedford, ...	18	-	North Attleborough, . .	1	-
Northbridge, ...	10	-	Somerville, ...	1	-
Boston, ...	8	-	Tisbury, ...	1	-
Quincy, ...	2	-	Total, ...	42	-
Lawrence, ...	1	-			

The following summary presents the number of reported cases and deaths in each year for the twenty-four years 1883–1906: —

Summary of Several Years, 1883–1906.

YEARS.	Cases.	Deaths.	YEARS.	Cases.	Deaths.
1883,	21	5	1896,	5	–
1884,	9	3	1897,	18	4
1885,	32	19	1898,	12	–
1886,	2	–	1899,	105	14
1887,	13	3	1900,	104	3
1888,	32	9	1901,	778	101
1889,	15	6	1902,	2,305	274
1890,	6	1	1903,	417	19[1]
1891,	5	3	1904,	100	9
1892,	19	2	1905,	44	2
1893,	45	9	1906,	42	–
1894,	185	33			
1895,	1	–	Totals,	4,315	519

[1] Four of these deaths, which occurred in the first days of January, 1903, were those of cases reported in December, 1902, and in reckoning the fatality of cases should be classed with the deaths of 1902.

The total number of reported cases in the twenty-four years was 4,315, and the deaths of these were 519, or 12.0 per cent.

The following table presents the data obtained from the returns received since and including 1888. The returns made previous to that date did not contain information of a sufficiently definite character to be included in this summary.

Smallpox in Massachusetts by Ages, and with Reference to Vaccination, 1888–1906.

PERIODS.	VACCINATED.		UNVACCINATED.		UNKNOWN.		TOTAL.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
0–1 year,	5	–	182	46	2	–	189	46
1–5 years,	37	–	500	56	4	1	541	57
5–10 years,	40	–	280	8	9	–	329	8
10–15 years,	49	–	138	4	2	–	189	4
15–20 years,	96	3	259	17	7	2	362	22
20–30 years,	455	29	582	79	21	5	1,058	113
30–40 years,	507	44	282	55	7	1	796	100
40–50 years,	316	30	132	34	8	–	456	64
Over 50 years,	212	38	65	17	3	1	280	56
Age unknown,	14	–	12	5	11	–	37	5
Totals,	1,731	144	2,432	321	74	10	4,237	475

CONSUMPTION.

The total number of deaths from this cause registered in 1906 was 4,608, a decrease of 94 deaths from the number of deaths occurring from this disease in 1905. The death-rate from consumption was less in 1906 than that of any year of record, except that of 1903, when the death-rate was the same, viz., 15.1.

The following figures present the deaths and death-rates, by ten-year periods, during the half century 1851–1900, and for the single years 1901, 1902, 1903, 1904, 1905 and 1906: —

Deaths and Death-rates from Consumption in Massachusetts, 1851–1906.

Periods.	Deaths.	Death-rates per 10,000.	Periods.	Deaths.	Death-rates per 10,000.
1851–60,	45,252	39.9	1902,	4,685	15.9
1861–70,	45,913	34.9	1903,	4,531	15.1
1871–80,	54,039	32.7	1904,	4,874	15.8
1881–90,	58,303	29.2	1905,	4,702	15.7
1891–1900,	54,374	21.4	1906,	4,608	15.1
1901,	5,033	17.5			

TYPHOID FEVER.

The following table presents the deaths and death-rates of these cities from this cause during the year 1906: —

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1906.

Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.	Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.
Newburyport,	9	6.1	Somerville,	11	1.6
Salem,	13	3.4	Northampton,	3	1.5
Taunton,	10	3.2	Newton,	5	1.3
North Adams,	7	3.2	Worcester,	16	1.2
Haverhill,	10	2.6	Holyoke,	6	1.2
Malden,	9	2.3	Cambridge,	11	1.1
Waltham,	6	2.2	Gloucester,	3	1.1
Melrose,	3	2.1	New Bedford,	8	1.0
Chelsea,	8	2.1	Fall River,	9	0.8
Springfield,	16	2.1	Lowell,	7	0.7
Boston,	121	2.0	Woburn,	1	0.7
Medford,	4	2.0	Beverly,	1	0.6
Everett,	6	2.0	Fitchburg,	2	0.6
Lawrence,	14	1.8	Chicopee,	1	0.5
Brockton,	9	1.8	Quincy,	1	0.3
Lynn,	14	1.8	Marlborough,	–	–
Pittsfield,	4	1.6	Total,	348	–

Death-rate for the above 33 cities, 1906, 1.7.

Following is a condensed summary from the report of 1900, from which it can be seen that a decided and continuous improvement in the death-rate from typhoid fever is taking place: —

Death-rates from Typhoid Fever per 10,000, 1871–1906, Massachusetts.

1871–75,	8.2	1891–95,	3.4
1876–80,	4.2	1896–1900,	2.6
1881–85,	4.1	1901–05,	1.9
1886–90,	4.6	1906,	1.7

For the entire State the death-rates from this cause in 1901, 1902, 1903, 1904, 1905 and 1906 were, respectively, 1.95, 1.83, 1.75, 1.75, 1.73 and 1.57 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in Newburyport (6.1), Salem (3.4), Taunton (3.2) and North Adams (3.2); and the lowest occurred in Fitchburg (0.6), Chicopee (0.5) and Quincy (0.3). Marlborough reported 15 cases of typhoid fever, with no deaths.

DIPHTHERIA.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1905, and for the year 1906: —

Deaths and Death-rates from Diphtheria per 10,000, 1876–1906, Massachusetts.

YEARS.	Deaths.	Death-rates.	YEARS.	Deaths.	Death-rates.
1876–80,	13,676	15.8	1896–1900,	6,331	4.7
1881–85,	8,944	9.5	1901–05,	4,259	2.9
1886–90,	8,857	8.4	1906,	743	2.4
1891–95,	7,652	6.4			

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

OTHER PREVENTABLE DISEASES.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum and whooping cough for the period of forty-one years, 1866–1906: —

Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infective Diseases by Five-year Periods, 1866–1905, and for the Year 1906.

	MEASLES.		SCARLET FEVER.		DYSENTERY.		CHOLERA INFANTUM.		WHOOPING COUGH.	
	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.
1866–70, . .	1,081	1.6	4,670	6.8	3,244	4.7	6,943	10.1	1,481	2.1
1871–75, . .	1,133	1.4	6,782	8.6	2,191	2.8	12,453	15.8	1,561	2.0
1876–80, . .	742	0.9	3,517	4.1	2,366	2.7	9,054	10.5	1,493	1.7
1881–85, . .	1,007	1.1	2,504	2.7	1,601	1.7	9,894	10.5	1,213	1.3
1886–90, . .	1,089	1.0	1,810	1.7	1,276	1.2	10,904	10.3	1,421	1.3
1891–95, . .	815	0.7	2,857	2.4	1,083	0.9	13,426	11.2	1,445	1.2
1896–1900, . .	948	0.7	1,358	1.0	1,434	1.1	11,865	8.9	1,465	1.1
1901–1905, . .	1,090	0.7	1,463	1.0	970	0.7	13,245	9.1	1,401	1.0
1906, . . .	208	0.7	135	0.4	176	0.6	2,525	8.3	509	1.7

The deaths from cerebro-spinal meningitis were 368, a marked decrease from the number of deaths recorded the preceding year, and represented a death-rate of 1.21 per 10,000 living.

There were 6 deaths from hydrophobia during the year, 2 from tetanus and 1 each from glanders, malignant pustule, anthrax and trichinosis.

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the recent reports of the Board, been presented under four different heads or groups. Since 1902, this series of statistics has been condensed as much as can be done consistently with a clear and intelligent method of presentation.

These summaries are defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They serve principally to show the seasonal prevalence of each of the chief infective diseases, and the mortality of children under five years old, in weekly periods. Beginning with the year 1875, this series of statistics has been annually reported (see page 475 of report for that year), and was first published as a summary in the report of 1883.

II. *The Reports of Certain Infective Diseases, — Diphtheria, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the reports of local boards of health forwarded during 1906 to the State Board as cases arose. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III. This summary was first published in the report of 1893, page 639.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. The population of these cities and towns, as estimated in 1906, constituted about 87 per cent. of the total population of the State. These reports are made under the requirements of the following statute: —

In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the state board of health. The form of such reports shall be prescribed and furnished by the state board of health. (Revised Laws, chapter 75, section 12.)

This summary was first presented in the report of 1894.

NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in Section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

I.

The Weekly Mortality Returns.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year ended Nov. 30, 1907. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty-five years or more, and also in a publication of the Board, a weekly bulletin, since and including 1883.[1]

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of only a portion of the population, the reporting places being chiefly the cities and large towns.

The population of the cities and towns contributing to these returns during the year was 2,212,084, or 72 per cent. of the total population.

The following items are embraced in this summary: —

Total deaths reported for each week.
Deaths of children under five years.
Deaths from consumption.
Deaths from acute lung diseases.
Deaths from typhoid fever.
Deaths from diphtheria.
Deaths from scarlet fever.
Deaths from measles.
Deaths from whooping cough.
Deaths from malarial fever.
Deaths from erysipelas.
Deaths from cerebro-spinal meningitis.
Deaths from influenza.
Deaths from hydrophobia.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

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[1] The bulletin was changed from a weekly to a monthly publication in January, 1906.

Summary Dec. 1, 1906, to Nov. 30, 1907.

	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Consumption.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Erysipelas.	Scarlet Fever.	Whooping Cough.	Hydrophobia.	Malaria.	Influenza.
1906.														
December 1,	649	156	83	44	15	6	-	3	2	2	3	-	-	-
8,	727	200	110	56	17	5	2	7	2	2	4	1	1	-
15,	691	174	124	47	20	9	2	2	1	1	5	-	-	-
22,	735	190	144	68	15	7	2	4	4	-	13	-	-	-
29,	735	156	130	53	11	3	1	7	-	4	5	-	-	-
1907.														
January 5,	805	193	155	66	16	5	4	3	2	3	7	-	-	-
12,	786	172	142	68	20	7	2	11	3	1	8	-	-	1
19,	785	163	160	69	9	8	-	1	1	4	6	-	-	3
26,	751	182	144	61	9	3	-	4	2	6	4	1	-	1
February 2,	828	201	163	81	13	1	2	3	1	5	5	-	-	5
9,	783	174	151	82	9	4	-	6	3	7	2	-	-	1
16,	816	193	154	85	9	5	-	8	-	7	7	-	-	1
23,	808	207	152	69	7	4	2	14	1	10	8	-	-	-
March 2,	798	213	154	71	14	1	-	7	1	7	2	-	-	1
9,	786	195	115	79	14	5	-	12	4	2	3	-	-	2
16,	799	195	161	72	11	1	1	10	3	5	3	-	1	1
23,	758	196	140	74	17	4	-	12	1	3	6	-	-	1
30,	771	191	120	68	6	4	1	12	3	5	3	-	-	-
April 6,	772	194	112	76	17	2	1	20	5	3	4	-	1	-
13,	748	174	107	76	9	3	2	20	2	4	3	-	-	-
20,	717	162	108	83	11	3	2	12	7	4	2	-	-	-
27,	838	201	124	69	17	3	1	9	2	-	2	-	-	-
May 4,	688	169	93	67	7	4	-	8	4	2	1	-	-	-
11,	707	184	117	51	14	3	3	15	1	3	1	-	-	-
18,	709	180	77	63	9	5	3	17	3	3	1	-	-	-
25,	648	171	90	66	13	3	4	17	1	2	5	-	-	-
June 1,	690	176	76	68	9	5	4	14	5	4	2	-	-	1
8,	664	142	80	68	10	5	2	9	2	6	2	-	-	-
15,	665	162	62	69	13	4	2	13	2	1	3	-	-	-
22,	656	169	63	54	7	1	5	17	1	6	-	-	-	-
29,	661	179	49	75	6	2	7	8	3	4	3	-	-	-
July 6,	554	157	41	55	10	4	4	4	3	4	2	-	-	-
13,	571	173	31	46	7	4	5	5	2	10	2	-	-	-
20,	644	219	31	55	5	6	2	9	-	6	1	-	-	-

27,	663	266	32	49	4	7	6	10	1	4	1	–	–	–
August 3,	776	343	30	58	10	8	2	5	3	–	8	–	–	–
10,	826	386	35	47	12	–	6	10	–	1	3	–	–	–
17,	861	408	28	63	9	4	2	6	2	5	4	–	–	–
24,	804	363	40	62	12	7	2	5	1	4	6	–	–	–
31,	818	401	46	48	7	5	4	3	1	1	6	–	1	–
September 7,	798	368	30	64	10	5	–	6	1	2	3	–	–	–
14,	730	308	33	48	9	14	3	5	1	3	1	–	–	–
21,	795	316	51	62	15	12	–	1	–	2	1	1	–	–
28,	692	276	51	49	9	10	–	6	3	1	1	–	–	–
October 5,	693	275	44	57	12	7	1	4	–	5	1	–	–	–
12,	725	259	36	50	15	11	–	1	–	3	2	–	–	1
19,	648	210	57	55	6	16	–	3	1	4	–	–	–	–
26,	710	197	59	58	17	10	–	3	1	1	1	–	–	–
November 2,	705	173	88	66	10	6	–	4	1	–	1	–	–	–
9,	640	155	73	63	5	11	–	5	–	–	1	–	–	–
16,	640	171	81	49	10	8	3	–	1	1	1	–	–	–
23,	690	180	85	51	18	12	1	8	–	7	2	–	–	–
30,	674	164	84	62	14	4	8	2	–	6	2	–	–	–
Totals,	38,631	11,382	4,746	3,315	600	296	104	410	94	186	173	3	4	19
Weekly average,	729	215	90	63	11.3	5.6	2.0	7.7	1.8	3.5	3.3	.057	.076	0.36
Rate per 1,000 deaths,	–	294.6	122.7	85.8	15.5	7.7	2.7	10.6	2.4	4.8	4.5	0.078	0.104	0.492
Rate per 1,000 population,	17.46	5.14	2.15	1.50	.27	.13	.05	.19	.04	.08	.08	.0014	.0018	.0086

Average reporting population, ... 2,212,084

Condensed Statistics, embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts for the Year ended Nov. 30, 1907.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	38,631	729	100.00	17.46
Deaths under five years,	11,382	215	29.46	5.14
Deaths from consumption,	3,315	63	8.58	1.50
Deaths from acute lung diseases,	4,746	90	12.27	2.15
Deaths from typhoid fever,	296	5.6	0.77	0.13
Deaths from diphtheria,	600	11.3	1.55	0.27
Deaths from scarlet fever,	186	3.5	0.48	0.08
Deaths from measles,	104	2	0.27	0.05
Deaths from whooping cough,	173	3.3	0.45	0.08
Deaths from malarial fever,	4	0.08	0.01	0.002
Deaths from erysipelas,	94	1.8	0.24	0.04
Deaths from cerebro-spinal meningitis,	410	7.7	1.06	0.19
Deaths from influenza,	19	0.36	0.05	0.009
Deaths from hydrophobia,	3	0.06	0.008	0.0014

The usual observations upon the weekly mortality statistics are omitted, and the foregoing short table, containing the essential statistics, supplies their place. The omission is made because information of the same character is presented in a different form in Section IV. of these summaries. The chief difference consists in the fact that the information given in this section (I.) is entirely voluntary and is detailed by weeks, while that of Section IV. is required by statute, the data not being forwarded to the Board until after the close of the year. The population which furnishes the statistics presented in Section IV. is considerably larger than that embraced in Section I., but both populations consist of the more densely settled parts of the State.

II.

Fatality of Certain Diseases.

Since the year 1891 the following statistics relative to the fatality of certain diseases have been gathered from the published reports of local boards of health. Until the passage of the law in 1893 this was the only source from which figures could be obtained on which to base the fatality of diseases as compared with cases. When the law (chapter 302, Acts of 1893) requiring local boards of health to report all cases of contagious diseases to the State Board of Health first went into effect very few returns were made, and it was not until after public notice had been given by the State Board to every board of health throughout the State that these returns came in with any regularity. The practice by the local boards of health of reporting cases of contagious diseases is now so well established, and the returns are so complete, it is no longer deemed necessary to continue the former method of basing the fatality of certain contagious diseases on the figures obtained through the annual reports of local boards, but, instead, to make use of the more complete returns as received from day to day at this office.

The diseases embraced in this summary in 1906 are diphtheria, scarlet fever, typhoid fever and measles.

The tabular list of cities and towns is omitted in this report. The summary of the figures for 1906 is as follows: —

Reported cases of diphtheria for the State,	8,305
Registered deaths from diphtheria,	743
Fatality (per cent.),	8.9
Reported cases of scarlet fever for the State,	5,223
Registered deaths from scarlet fever,	135
Fatality (per cent.),	2.5
Reported cases of typhoid fever for the State,	2,986
Registered deaths from typhoid fever,	477
Fatality (per cent.),	16.0
Reported cases of measles for the State,	15,553
Registered deaths from measles,	208
Fatality (per cent.),	1.3

The following table presents the summary of these statistics for the sixteen years 1891–1906: —

Reported Cases of Infective Diseases in Massachusetts.

Diphtheria.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria.

[Antitoxin Period.]

	1905.	1906.	Total 1895-1906.
Reported cases,	5,783	8,305	88,018
Deaths,	652	743	10,646
Fatality (per cent.),	11.3	8.9	12.1

Scarlet Fever.

	1905.	1906.	Total 1891-1906.
Reported cases,	4,112	5,223	81,265
Deaths,	117	135	4,302
Fatality (per cent.),	2.8	2.5	5.2

Typhoid Fever.

Reported cases,	3,064	2,986	40,648
Deaths,	520	477	7,158
Fatality (per cent.),	17.0	16.0	17.6

Measles.

Reported cases,	7,876	15,553	133,058
Deaths,	177	208	1,821
Fatality (per cent.),	2.2	1.3	1.4

In the foregoing tables the statistics relating to diphtheria have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. For the latter period the figures for 1905 and 1906 are given and the total for the twelve years 1895 to 1906, inclusive. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1906) it was 12.1 per cent., or less than half as large.

III.

OFFICIAL RETURNS OF NOTIFIED DISEASES DANGEROUS TO THE PUBLIC HEALTH, FOR THE YEAR ENDED NOV. 30, 1907.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year ended Nov. 30, 1907, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except smallpox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: actinomycosis, Asiatic cholera, cerebro-spinal meningitis, diphtheria, glanders, leprosy, malignant pustule, measles, scarlet fever, smallpox, tetanus, trichinosis, tuberculosis, typhoid fever, typhus fever, varicella, whooping cough, yellow fever.

The whole number of cases of infective diseases reported to the Board in the year ended Nov. 30, 1907, under the provisions of this act, was 30,529,[1] which was divided chiefly as follows: —

Reported cases of smallpox,	164
Reported cases of scarlet fever,	7,860
Reported cases of diphtheria,	9,098
Reported cases of typhoid fever,	2,350
Reported cases of measles,	5,688
Reported cases of cerebro-spinal meningitis,	428
Total,	25,588

The summary for the fourteen years and three months 1893–1907 is as follows: —

	Reported Cases of —						Totals.
	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	
1893 (four months only),	35	2,914	1,109	1,525	1,503	-	7,086
1894,	181	6,731	4,178	2,372	2,133	-	15,595
1895,	1	6,194	7,806	2,438	4,868	-	21,307
1896,	5	3,801	8,515	2,637	6,362	-	21,320
1897,	18	5,495	7,613	2,104	12,695	-	27,925
1898,	10	3,667	3,980	2,196	4,478	-	14,331
1899,	105	5,349	7,134	2,776	12,355	-	27,719
1900,	104	6,396	12,641	2,967	10,507	-	32,615
1901,	773	4,356	9,793	2,689	9,398	-	27,009
1902,	2,314	4,613	7,036	2,721	17,249	-	33,933
1903,	422	5,877	6,888	2,955	9,430	-	25,572
1904,	100	4,100	6,772	2,605	12,511	-	26,088
1905 (11 months),	44	3,594	5,059	2,794	6,107	455	18,053
1906 (Dec. 1, 1905–Nov. 30, 1906).	35	5,162	7,967	3,093	17,048	291	33,596
1907,	164	7,860	9,098	2,350	5,688	428	25,588
Totals,	4,311	76,109	105,589	38,222	132,332	1,174	357,737

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[1] Included in this figure are 8 cases of hydrophobia and 1 case of mumps.

By months these diseases were reported as follows: —

Cases of Infective Diseases reported to the State Board of Health by Months from Dec. 1, 1906, to Nov. 30, 1907.

MONTHS.	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.
December,	–	580	1,060	165	273	19
January,	–	1,495	1,023	116	257	21
February,	–	949	703	105	295	34
March,	24	887	760	90	543	54
April,	90	725	774	92	852	89
May,	20	513	680	78	805	67
June,	7	542	684	96	947	57
July,	2	340	521	138	417	17
August,	15	293	580	267	236	15
September,	1	403	616	515	116	19
October,	1	489	838	454	169	15
November,	4	644	859	234	778	21
Totals,	164	7,860	9,098	2,350	5,688	428

The following table is introduced for the purpose of facilitating the comparison of the seasonal prevalence of the diseases named in the table, in different years. By means of the method employed, the errors due to the difference in the length of the months are eliminated. The figures should be read as follows: for example, the mean daily number of reported cases of diphtheria throughout the year, Dec. 1, 1906, to Nov. 30, 1907, was 24.9; of scarlet fever, 21.5; of typhoid fever, 6.4; and of measles, 15.6. During the month of December the mean daily number of reported cases of these diseases was: for diphtheria, 34.2; scarlet fever, 18.7; typhoid fever, 5.3; and for measles, 8.8 (see columns marked A). Assuming a standard of 10 as a daily mean throughout the year for each disease, the ratios for December were as follows: diphtheria, 13.7; scarlet fever, 8.7; typhoid fever, 8.3; and measles, 5.6 (see columns marked B). So that for each 10 cases of diphtheria reported as a daily mean throughout the year, Dec. 1, 1906, to Nov. 30, 1907, there were 13.7 in December, 13.3 in January, 10.1 in February, etc.

From this table it appears that the maximum prevalence of diphtheria was in December and the minimum in July. January, February, April, October and November were also above the mean in intensity of prevalence.

The prevalence of scarlet fever was above the mean in January, February, March and April, and below it in the remaining months, excepting November, when it stood at the daily mean for the year. The maximum occurred in January and the minimum in August, as in the previous year.

Typhoid fever was below the mean in the intensity of its prevalence in the months December to July, inclusive, rising to a maximum in September.

The prevalence of measles was above the mean in March, April, May, June and November, and below it in the remaining months, the maximum occurring in June and the minimum in September.

Certain Infective Diseases.—Seasonal Intensity of Prevalence.

MONTHS.	DIPHTHERIA.			SCARLET FEVER.			TYPHOID FEVER.			MEASLES.		
	1907.		1906.	1907.		1906.	1907.		1906.	1907.		1906.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.
December,[1] .	34.2	13.7	10.7	18.7	8.7	11.8	5.3	8.3	10.4	8.8	5.6	12.2
January, . .	33.0	13.3	9.9	48.2	22.4	13.5	3.7	5.8	4.4	8.3	5.3	18.2
February, .	25.1	10.1	9.4	33.9	15.8	10.5	3.7	5.8	3.2	10.5	6.7	24.0
March, . .	24.5	9.8	8.8	28.6	13.3	12.2	2.9	4.5	4.6	17.5	11.2	26.2
April, . .	25.8	10.4	7.5	24.2	11.3	11.6	3.1	4.8	5.8	28.4	18.2	19.4
May, . .	21.9	8.8	7.3	16.5	7.7	13.0	2.5	3.9	4.2	26.0	16.7	11.8
June, . .	22.8	9.2	7.6	18.1	8.4	10.7	3.2	5.0	5.1	31.6	20.3	5.4
July, . .	16.8	6.7	5.5	11.0	5.1	5.7	4.5	7.0	5.2	13.6	8.7	2.1
August, . .	18.7	7.5	6.7	9.5	4.4	4.2	8.6	13.4	13.3	7.6	4.9	0.6
September, .	20.5	8.2	11.0	13.4	6.2	5.7	17.2	26.9	29.3	3.9	2.5	0.2
October, . .	27.0	10.8	17.4	15.8	7.3	10.4	14.6	22.8	22.0	5.5	3.5	0.2
November, .	28.6	11.5	18.3	21.5	10.0	10.8	7.8	12.2	12.1	25.9	16.6	0.4
Mean, .	24.9	10.0	10.0	21.5	10.0	10.0	6.4	10.0	10.0	15.6	10.0	10.0

[1] The figures for December, in the first two columns, are for 1906, and in the third column, for 1905.

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
Abington, . . .	23	6	3	16	–	–	–	–
Acton, ...	1	4	1	1	–	–	–	–
Acushnet, . . .	–	–	1	–	–	–	–	–
Adams, ...	69	–	15	9	–	–	–	–
Agawam, . . .	3	–	2	5	–	–	–	–
Amesbury, . . .	26	86	19	9	–	–	–	–
Amherst, . . .	4	1	7	2	–	–	–	–
Andover, . . .	5	5	14	9	1	–	–	–
Arlington, . . .	19	5	50	12	3	4	–	–
Ashburnham, . .	–	–	6	–	–	–	–	–
Ashfield, . . .	2	13	1	–	–	–	–	–
Ashland, . . .	–	1	2	–	–	–	–	–
Athol, ...	8	–	13	1	–	1	–	–
Attleborough, . .	9	2	4	3	5	2	–	1
Auburn, . . .	8	–	–	2	–	–	–	–
Avon, ...	–	1	6	1	1	–	–	–
Ayer, ...	1	6	2	3	1	–	–	–
Barnstable, . . .	8	3	10	–	1	–	–	1
Barre, ...	5	9	26	2	–	–	–	–
Bedford, . . .	2	3	2	–	–	–	–	–
Belchertown, . .	–	8	3	5	–	–	–	–
Bellingham, . . .	1	–	–	1	–	–	–	–
Belmont, . . .	2	–	7	2	–	–	–	–
Berkley, . . .	1	–	–	–	–	–	–	–
Berlin, ...	5	–	5	–	–	–	–	–
Beverly, . . .	54	2	26	20	4	–	–	–
Billerica, . . .	1	–	2	–	–	–	–	–
Blackstone, . . .	2	–	1	2	–	–	–	–
Bolton, ...	3	1	–	–	–	–	–	–
Boston, ...	2,406	1,290	2,378	617	2,414	253	5	–
Bourne, ...	5	2	5	–	–	–	–	–
Boxford, . . .	1	–	–	–	–	–	–	–
Boylston, . . .	4	–	–	–	–	1	–	–
Braintree, . . .	9	19	16	1	4	1	–	–
Brewster, . . .	–	1	–	–	–	–	–	–
Bridgewater, . .	14	–	3	–	3	1	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
Brimfield, ...	1	–	–	1	1	–	–	–
Brockton, . .	125	24	79	42	12	–	–	–
Brookfield, . . .	–	–	1	1	–	–	–	–
Brookline, . . .	42	33	56	17	38	1	–	–
Cambridge, . . .	344	59	386	88	195	20	–	2
Canton, ...	3	3	28	1	4	–	–	–
Carver, ...	3	–	–	–	1	–	–	–
Charlton, . . .	–	–	1	1	–	–	–	–
Chelmsford, . . .	6	3	3	–	–	–	–	–
Chelsea, ...	128	57	133	14	22	–	16	–
Cheshire, . . .	–	–	1	–	1	–	–	–
Chester, ...	1	–	1	–	1	–	–	–
Chesterfield, . . .	–	7	–	7	–	–	–	–
Chicopee, . . .	68	207	145	16	21	–	–	–
Clinton, ...	21	2	16	5	–	3	–	–
Colrain, ...	4	–	–	2	–	–	–	–
Concord, . . .	2	122	45	3	–	–	–	–
Cummington, . .	4	–	2	–	–	–	–	–
Dalton, ...	5	–	3	–	–	–	–	–
Dana, ...	3	3	–	–	–	–	–	–
Danvers, . . .	28	3	18	18	1	2	–	–
Dartmouth, . . .	–	–	2	1	–	–	–	–
Dedham, . . .	22	4	2	4	3	5	–	–
Deerfield, . . .	–	16	13	1	–	–	–	–
Dennis, ...	–	–	–	–	–	1	–	–
Dighton, . . .	3	–	1	1	–	–	–	–
Douglas, . . .	10	–	1	4	–	–	–	–
Dracut, ...	4	–	–	–	–	–	–	–
Dudley, ...	7	–	–	–	–	–	–	–
Dunstable, . . .	1	–	–	–	–	–	–	–
Duxbury, . . .	–	19	–	3	–	–	–	–
East Bridgewater, .	6	22	2	2	–	1	–	–
East Longmeadow, .	8	122	3	1	–	–	–	–
Easton, ...	3	10	1	9	–	–	–	6
Egremont, . . .	1	–	–	–	–	–	–	–
Erving, ...	8	20	3	–	–	–	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
Essex, ...	5	–	6	–	–	–	–	–
Everett, ...	101	7	126	18	34	4	–	4
Fairhaven, . . .	3	–	2	–	–	–	–	–
Fall River, . . .	51	8	78	62	62	20	3	2
Falmouth, . . .	1	17	12	–	–	–	–	–
Fitchburg, . . .	54	80	36	21	–	–	–	4
Foxborough, . . .	9	1	4	2	–	–	–	–
Framingham, . .	1	6	25	2	–	–	–	–
Franklin, . . .	8	–	13	3	–	–	–	–
Freetown, . . .	–	–	9	1	–	–	–	–
Gardner, . . .	60	1	170	7	–	–	–	–
Gill, ...	1	6	40	–	–	–	–	–
Gloucester, . . .	132	5	23	4	7	1	1	–
Grafton, . . .	7	–	2	2	–	–	–	–
Great Barrington, .	7	–	5	5	1	–	–	–
Greenfield, . . .	2	8	5	4	–	–	–	–
Groton, ...	2	4	9	1	–	–	–	–
Groveland, . . .	3	1	6	–	–	–	13	–
Hadley, ...	3	1	2	3	1	–	–	–
Halifax, . . .	–	–	3	–	–	1	–	–
Hamilton, . . .	9	–	–	–	–	–	–	–
Hampden, . . .	–	3	–	–	–	–	–	–
Hancock, . . .	–	–	–	–	–	–	1	–
Hanover, . . .	–	9	–	–	–	–	–	–
Hanson, ...	1	4	1	–	–	–	–	–
Hardwick, . . .	34	–	19	–	–	–	–	–
Harvard, . . .	–	–	–	–	–	1	–	–
Harwich, . . .	8	1	1	–	–	–	–	–
Hatfield, . . .	12	13	47	–	–	–	–	–
Haverhill, . . .	145	138	127	51	116	4	1	116
Heath, ...	–	2	–	–	–	–	–	–
Hingham, . . .	20	–	10	1	–	–	–	–
Hinsdale, . . .	2	3	1	1	–	–	–	–
Holbrook, . . .	21	1	7	1	–	–	–	–
Holden, ...	2	14	4	2	–	–	–	–
Holliston, . . .	1	–	–	–	–	–	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
Holyoke,	190	490	138	7	6	4	–	–
Hopedale,	7	–	6	1	–	–	–	–
Hopkinton,	19	3	3	1	1	–	–	–
Hubbardston,	–	–	7	1	–	–	–	–
Hudson,	52	1	2	7	1	–	–	–
Hull,	1	5	1	6	1	–	–	–
Huntington,	2	–	2	2	–	–	–	–
Hyde Park,	74	10	44	10	3	2	–	9
Ipswich,	5	7	5	7	4	1	–	–
Kingston,	1	37	1	4	–	–	–	5
Lancaster,	5	3	7	2	–	–	–	–
Lanesborough,	2	–	–	–	–	–	–	–
Lawrence,	176	141	103	119	–	6	112	–
Lee,	–	–	4	4	–	–	2	–
Leicester,	3	–	2	1	–	–	–	–
Lenox,	17	2	1	1	–	–	2	–
Leominster,	92	21	35	13	–	–	–	–
Lexington,	11	1	10	1	4	–	–	–
Littleton,	–	1	1	–	–	–	–	–
Longmeadow,	1	–	6	–	–	–	–	–
Lowell,	476	114	134	67	–	22	–	7
Lynn,	186	491	244	97	–	7	–	–
Malden,	104	62	179	33	–	–	–	–
Manchester,	6	3	5	–	–	–	–	–
Mansfield,	10	24	–	1	1	–	–	–
Marblehead,	13	17	16	8	–	–	–	–
Marion,	–	–	3	–	–	–	–	–
Marlborough,	11	4	12	15	–	–	–	–
Marshfield,	3	3	3	1	–	–	–	–
Mattapoisett,	1	–	–	2	–	–	–	–
Maynard,	1	1	–	2	1	2	–	–
Medfield,	3	6	1	–	–	–	–	–
Medford,	57	105	50	14	15	1	–	–
Medway,	1	–	6	1	–	–	–	–
Melrose,	45	13	70	1	2	–	–	–
Mendon,	2	1	1	2	–	–	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
Merrimac, . . .	1	–	9	3	–	–	–	–
Methuen, . . .	42	6	16	4	–	–	4	–
Middleborough, . .	3	–	2	1	–	–	–	–
Middlefield, . . .	4	–	–	–	–	–	–	–
Middleton, . . .	1	1	2	4	–	1	–	–
Milford, ...	12	–	26	1	–	1	–	–
Millbury, . . .	26	1	2	–	–	–	–	–
Millis, ...	4	–	–	–	1	–	–	–
Milton, ...	32	4	21	3	5	1	–	–
Monson, . . .	14	1	14	–	5	–	–	–
Nahant, ...	4	–	2	–	–	–	–	–
Natick, ...	5	–	6	5	–	1	–	–
Needham, . . .	7	–	–	–	–	–	–	–
New Bedford, . .	133	62	102	72	25	5	–	4
New Salem, . . .	–	–	2	–	–	–	–	–
Newbury, . . .	1	3	5	4	–	–	–	–
Newburyport, . .	52	5	37	18	2	3	–	–
Newton, ...	118	14	106	9	42	9	–	2
Norfolk, . . .	1	–	–	–	–	–	–	–
North Adams, . .	60	15	15	23	9	1	–	2
North Andover, . .	8	3	4	8	1	1	–	–
North Attleborough, .	4	2	9	1	–	–	–	–
North Brookfield, . .	–	–	3	2	–	–	–	–
North Reading, . .	–	1	1	3	–	–	–	–
Northampton, . .	41	61	63	23	14	–	–	15
Northborough, . .	5	4	7	2	–	–	–	–
Northbridge, . . .	35	57	7	7	1	–	–	–
Northfield, . . .	2	–	11	–	–	–	–	–
Norton, ...	–	–	30	–	–	–	–	–
Norwell, . . .	1	–	8	3	–	–	–	–
Norwood, . . .	4	7	27	1	6	1	–	2
Oakham, . . .	–	5	1	–	–	–	–	–
Orange, ...	–	–	17	3	–	–	–	–
Oxford, ...	–	–	2	2	–	–	–	3
Palmer, ...	12	72	2	18	–	–	–	–
Peabody, . . .	25	2	51	3	–	–	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebrospinal Meningitis.	Smallpox.	Whooping Cough.
Pembroke,	2	13	–	–	–	–	–	–
Pepperell,	3	–	21	4	–	–	–	–
Petersham,	1	–	–	–	–	–	–	–
Phillipston,	–	–	2	–	–	–	–	–
Pittsfield,	32	50	38	29	7	1	2	1
Plainville,	–	–	–	–	1	–	–	–
Plymouth,	13	31	5	1	–	–	–	–
Princeton,	–	14	–	3	–	–	–	–
Provincetown,	–	–	–	6	–	–	–	–
Quincy,	59	35	45	16	12	2	–	2
Randolph,	3	–	–	1	–	–	–	–
Raynham,	2	–	–	–	–	–	–	–
Reading,	54	2	12	6	–	–	–	–
Rehoboth,	2	3	10	2	–	–	–	–
Revere,	71	–	45	6	6	4	–	–
Rockland,	19	21	6	3	–	–	–	–
Rockport,	5	–	–	1	1	–	–	–
Rowley,	4	–	8	2	–	–	–	–
Russell,	–	–	2	–	–	–	–	–
Rutland,	–	–	–	–	1,232	–	–	–
Salem,	111	65	75	29	24	2	–	2
Salisbury,	10	–	4	2	–	–	–	–
Sandisfield,	8	–	–	–	–	–	–	–
Saugus,	24	–	14	–	4	–	–	–
Savoy,	–	–	–	–	–	–	–	9
Scituate,	–	–	7	–	–	–	–	–
Seekonk,	1	–	3	1	–	–	–	–
Sharon,	2	4	9	1	2	–	–	–
Sherborn,	–	–	2	–	–	–	–	–
Shirley,	6	1	4	1	–	–	–	8
Shrewsbury,	4	1	3	–	–	–	–	–
Shutesbury,	–	–	1	–	–	–	–	–
Somerset,	–	–	3	17	–	–	–	–
Somerville,	188	33	388	88	73	4	2	–
South Hadley,	13	5	6	3	–	–	–	–
Southampton,	2	–	–	–	–	–	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
Southborough, . . .	–	–	6	–	–	–	–	–
Southbridge, . . .	13	–	5	4	–	–	–	–
Springfield, . . .	228	536	284	93	16	2	–	6
Sterling, . . .	3	–	–	–	–	–	–	–
Stockbridge, . . .	2	3	1	1	–	–	–	–
Stoneham, . . .	19	1	5	1	–	–	–	–
Stoughton, . . .	21	3	12	–	–	–	–	–
Stow, ...	–	–	–	1	–	–	–	–
Sturbridge, . . .	2	–	–	–	–	–	–	–
Sunderland, . . .	–	–	7	–	–	–	–	–
Sutton, ...	22	–	1	3	–	–	–	–
Swampscott, . . .	13	27	13	6	1	1	–	–
Swansea, . . .	–	–	1	2	–	–	–	–
Taunton, . . .	25	1	20	10	–	3	–	6
Templeton, . . .	24	1	8	–	–	–	–	–
Tewksbury, . . .	2	–	3	–	–	–	–	–
Tisbury, . . .	–	2	–	2	–	1	–	–
Topsfield, . . .	–	1	–	3	–	–	–	–
Townsend, . . .	–	–	3	–	–	–	–	–
Truro, ...	–	–	1	1	–	–	–	–
Upton, ...	5	–	1	–	–	1	–	–
Uxbridge, . . .	27	1	8	–	–	–	–	–
Wakefield, . . .	13	25	27	4	–	–	–	–
Wales, ...	2	–	–	3	–	–	–	–
Walpole, . . .	11	3	15	1	–	–	–	1
Waltham, . . .	103	4	35	43	24	–	–	2
Ware, ...	40	–	6	–	–	–	–	–
Wareham, . . .	–	1	2	–	1	–	–	–
Warren, ...	1	–	5	–	–	–	–	1
Watertown, . . .	30	2	24	3	1	3	–	2
Wayland, . . .	1	–	2	–	–	–	–	–
Webster, . . .	6	–	3	–	–	–	–	–
Wellesley, . . .	9	4	16	3	2	–	–	–
Wenham, . . .	–	1	6	–	–	–	–	–
West Bridgewater, .	–	–	1	–	–	–	–	–
West Newbury, . .	–	–	5	–	–	–	–	–

Cases of Infective Diseases reported to the State Board of Health from 276 Cities and Towns, from Nov. 30, 1906, to Nov. 30, 1907 — Concluded.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.
West Springfield, . .	36	8	31	1	-	1	-	-
West Stockbridge, .	8	-	-	-	-	-	-	-
Westborough, . .	4	85	11	8	-	-	-	-
Westfield, . . .	14	13	26	12	10	-	-	-
Westford, . . .	-	-	3	1	6	-	-	-
Westhampton, . .	-	-	-	-	-	1	-	-
Westminster, . .	-	-	12	-	-	-	-	-
Weston, . . .	-	1	4	2	-	-	-	-
Westport, . . .	1	-	4	-	1	-	-	-
Westwood, . . .	-	1	6	-	-	-	-	-
Weymouth, . . .	11	7	13	1	1	-	-	-
Whately, . . .	3	-	6	-	-	-	-	-
Whitman, . . .	8	153	3	1	-	-	-	-
Wilbraham, . . .	3	4	4	3	-	-	-	-
Williamsburg, . .	-	4	14	1	-	-	-	-
Williamstown, . .	7	1	38	3	-	-	-	-
Winchendon, . .	12	2	9	2	-	-	-	-
Winchester, . . .	6	16	8	3	-	-	-	-
Winthrop, . . .	20	-	12	4	6	-	-	-
Woburn, . . .	24	3	80	3	3	2	-	-
Worcester, . . .	1,176	56	255	86	-	4	-	5
Worthington, . .	-	-	-	1	-	-	-	-
Wrentham, . . .	2	-	1	-	-	-	-	-
Yarmouth, . . .	1	11	-	2	-	-	-	-
Total, . . .	9,098	5,688	7,860	2,350	4,542	428	164	230

Actinomycosis occurred in the following place: —

Lynn, ...	1

Anthrax occurred in the following place: —

Lynn, ...	1

Erysipelas occurred in the following places: —

Chelsea, ...	1
Fall River, ...	6

Peabody,	1
Salem,	5
Somerville,	1
Springfield,	14
Wellesley,	1
	29

Hydrophobia occurred in the following places: —

Brookline,	1
Quincy,	1
Revere,	5
Westfield,	1
	8

Leprosy occurred in the following place: —

Boston,	4

Malaria occurred in the following place: —

Brookline,	6

Mumps occurred in the following place: —

Everett,	1

Ophthalmia neonatorum occurred in the following places: —

Barnstable,	1
Melrose,	1
Quincy,	1
	3

Tetanus occurred in the following places: —

Barnstable,	1
Fall River,	3
Lowell,	1
Marblehead,	2
North Andover,	1
	8

Trichinosis occurred in the following place: —

Chesterfield,	7

Varicella occurred in the following places: —

Abington,	1
Barnstable,	17
Barre,	2
Beverly,	2
Brockton,	2
Brookline,	8
Cambridge,	3
Chelsea,	3
Dedham,	1
Erving,	2
Everett,	5
Fitchburg,	1
Haverhill,	10
Ipswich,	1
Kingston,	3
Lowell,	10
Lynn,	1
Maynard,	2
Medway,	1
Methuen,	2
Milton,	1
North Andover,	1
Norton,	1
Norwood,	2
Pittsfield,	1
Somerville,	3
Springfield,	7
Waltham,	1
Watertown,	1
Wellesley,	4
Worcester,	2
	101

List of Cities and Towns from which no Reports were received.

I. Cities.

None.

II. Towns having a Population of More than 5,000.

Easthampton,
Montague,
Spencer. — 3.

III. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Buckland,
Charlemont,
Chatham,
Clarksburg,
Cohasset,
Conway,
Edgartown,
Georgetown,
Lincoln,
Ludlow,
Lunenburg,
Nantucket,
New Marlborough,
Oak Bluffs,
Orleans,
Rochester,
Sandwich,
Sheffield,
Shelburne,
Southwick,
Sudbury,
West Boylston,
West Brookfield,
Wilmington. — 24.

IV. Towns having Less than 1,000 Inhabitants.

Alford,
Ashby,
Becket,
Bernardston,
Blandford,
Boxborough,
Burlington,
Carlisle,
Chilmark,
Dover,
Eastham,
Enfield,
Florida,
Gay Head,
Goshen,

IV. Towns having Less than 1,000 Inhabitants — Concluded.

Gosnold,
Granby,
Granville,
Greenwich,
Hawley,
Holland,
Plymouth,
Leverett,
Leyden,
Lynnfield,
Mashpee,
Monroe,
Monterey,
Montgomery,
Mount Washington,
New Ashford,
New Braintree,
Otis,
Paxton,
Pelham,
Peru,
Plainfield,
Plympton,
Prescott,
Richmond,
Rowe,
Royalston,
Tolland,
Tyngsborough,
Tyringham,
Warwick,
Washington,
Wellfleet,
Wendell,
West Tisbury,
Windsor. — 51.

A supply of postal cards for the purpose of reporting infectious diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the secretary of the State Board, Room 141, State House, Boston.

IV.

OFFICIAL RETURNS OF DEATHS IN CITIES AND LARGE TOWNS (REVISED LAWS, CHAPTER 75, SECTION 12).

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year 1906 comprise the same list as that of 1905. This list embraces all of the 33 cities and the towns having more than 5,000 inhabitants in each.

Hingham and Williamstown[1] have made returns this year, although their populations fell below 5,000 in 1905.

Reading and Easton have again voluntarily contributed returns of deaths to the Board, although not required by law to do so.

The list for the year 1906 includes 101 cities and towns. The total estimated population of this group of cities and towns in 1906, based upon the rate of growth between the two census years 1900 and 1905, was 2,636,318, or about 87 per cent. of the estimated total population of the State.

The whole number of registered deaths in these cities and towns in 1906 was 43,779, and the death-rate, as calculated from the foregoing estimated population, was 16.61 per 1,000 of the living population, that of the previous year having been 16.77 per 1,000, and that of 1904, 15.47 per 1,000.

The death-rate for the year 1906 was lower than that of 1905, and considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

Sexes. — The number of deaths of males was 22,507, or 51.42 per cent. of the whole number of deaths whose sex was known; and the deaths of females were 21,263, or 48.58 per cent. There were 9 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows: —

AGES.	Deaths 1906.	PERCENTAGES OF ALL DEATHS.	
		1906.	1905.
Under 1 year,	9,651	22.06	21.27
1 to 20 years,	6,910	15.80	13.74
20 to 50 years,	10,480	23.96	24.65
50 and over,	16,698	38.18	40.34

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[1] In 1900 a part of Williamstown was annexed to North Adams.

Infant Mortality. — The deaths of infants under one year old were 9,651, or 22.06 per cent. of the total mortality, as compared with 21.27 per cent. in 1905, a higher rate of infant mortality than since the year 1900, when the rate was 23; that of the five years 1902–06, respectively, constituted 21.7, 21.38, 21.34, 21.27 and 22.06 per çent. of the total mortality.

The deaths of children under five years old were 13,692, or 31.1 per cent. of the total mortality, as compared with 28.9 per cent. for the same age in 1905.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 40; in 1905 it was 59.

Still-births. — The number of still-births was 3,475, and when compared with the total mortality (still-births included), this was 7.4 per cent. of the total deaths and still-births combined. In 1905 the percentage was 6.1.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths 1906.	Percentages.	
		1906.	1905.
First quarter,	11,141	25.45	26.58
Second quarter,	10,544	24.09	23.89
Third quarter,	11,475	26.21	26.57
Fourth quarter,	10,616	24.25	22.96
Total,	43,776	100.00	100.00

These percentages differ but little from the mean of several years, which usually shows the highest mortality in the third quarter of the year. In 1899, 1901, 1903 and 1904 the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 527 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

	Deaths in Each Month.	Mean Daily Deaths per Month 1906.	CENTESIMAL RATIO.	
			1906.	1905.
January,	3,613	116.5	97.2	104.7
February,	3,576	127.7	106.5	111.1
March,	3,952	127.5	106.3	108.0
April,	3,781	126.0	105.1	102.6
May,	3,618	116.7	97.3	98.0
June,	3,145	104.8	87.4	86.9
July,	3,699	119.3	99.5	107.1
August,	4,125	133.1	111.0	112.8
September,	3,651	121.7	101.5	96.1
October,	3,551	114.5	95.5	89.2
November,	3,290	109.7	91.5	91.7
December,	3,775	121.8	101.6	92.3
Annual mean,	–	119.9	100.0	100.0

The figures in the foregoing table indicate a departure in excess of the mean death-rate in February, March, April, August, September and December, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1906, was 11 per cent. and those of February and March, 1906, were, respectively, 6.5 and 6.3 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1906, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mortality, since serious epidemics have not prevailed in the State either in the past year or in any of the years of the past decade.

Death-rates of Cities and Large Towns. — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the estimated population. They vary from a minimum of 9.2 in Wellesley to 23.17 per 1,000 in Newburyport.

The following cities and towns had death-rates above 19 per 1,000 in

1906: Newburyport, 23.2; Ware, 20.8; Lowell, 19.9; Salem, 19.9; Methuen, 19.6; Fall River, 19.6; Milford, 19.4; Athol, 19.1; Hingham, 19.1.

Of the foregoing, Newburyport, Lowell, Salem, Fall River and Hingham had death-rates above 19 per 1,000 in 1905.

The following cities and towns had death-rates less than 12 per 1,000 in 1906: Williamstown, 11.9; Newton, 11.8; Everett, 11.5; Bridgewater, 10.5; Concord, 10.1; Winchester, 10; Wellesley, 9.2; of these, Wellesley and Winchester also had death-rates below 12 per 1,000 in 1905.

The following table presents the mean death-rates of cities over 25,000 population for the five census years 1870, 1875, 1880, 1885 and 1890, together with the death-rates for the years 1900 and 1906.

In all of these cities except Taunton there appears to have been decided improvement. In Taunton, the death-rate for 1906 is still somewhat higher than the mean, though lower than in 1905.

Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Five Census Years 1870, 1875, 1880, 1885, 1890, and for 1900 and 1906.

	Mean Death-rates, 1870, 1875, 1880, 1885 and 1890.	Death-rate, 1900.	Death-rate, 1906.		Mean Death-rates, 1870, 1875, 1880, 1885 and 1890.	Death-rate, 1900.	Death-rate, 1906.
Boston,	24.1	20.8	18.9[1]	Brockton,	16.2	13.8	11.5
Worcester,	19.7	18.8	17.5[1]	Haverhill,	17.8	15.2	16.0
Fall River,	23.4	21.0	19.6	Salem,	22.1	19.6	19.9
Lowell,	22.5	19.5	19.9	Chelsea,	19.7	19.1	18.2[1]
Cambridge,	19.9	16.8	15.8	Malden,	17.0	14.6	13.8
Lynn,	17.8	15.8	14.5	Newton,	13.1	14.9	11.9
Lawrence,	26.5	20.0	17.5	Fitchburg,	17.0	14.9	15.4
New Bedford,	20.9	20.6	17.3	Taunton,	19.5	21.1	20.7[1]
Springfield,	19.3	18.4	14.9	Gloucester,	21.8	14.6	13.7
Somerville,	18.2	15.7	14.2	Quincy,	18.7	14.4	13.3
Holyoke,	23.1	21.5	17.7	Waltham,	15.3	15.6	13.2

[1] These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of non-residents in Boston and deaths in public and private institutions in the other 3 cities, the death-rates would be reduced to 15.0 in Chelsea, 17.2 in Boston, 17.4 in Taunton and 16.2 in Worcester.

Causes of Death. — In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified according to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the census population of the group for 1906, as well as for each of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 166.10 per 10,000 living, or, as usually stated, 16.61 per 1,000, was lower than that of 1905, though higher than that of the years 1904, 1903 and 1902, when it was 15.46, 16.13 and 16.20 respectively. The population comprised in these returns constitutes about 87 per cent. of that of the whole State.

The decline in the general death-rate is chiefly due to a decrease in the relative number of deaths from infectious diseases, and especially from those which are usually considered preventable.

The death-rate from each of the following causes was less than that of 1905: consumption, measles, typhoid fever, cerebro-spinal meningitis, erysipelas, puerperal fever, influenza, malarial fever, cholera infantum, dysentery, diarrhœa and cholera morbus, pneumonia, bronchitis, diseases of the heart, diseases of the brain and spinal cord, and diseases of the kidneys. Those of consumption, measles, malarial fever, dysentery and bronchitis were also less than the death-rates from the same causes in any of the last five years. Scarlet fever has stood at the same rate for the past three years. There were no deaths from smallpox in 1906.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infectious diseases, and also shows that this combined death-rate in 1906 was less, with the exception of 1904, than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the twelve years (1895–1906) in the cities and towns included in this report (about six-sevenths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infective Diseases.

YEAR.	Combined Death-rate per 10,000.	YEAR.	Combined Death-rate per 10,000.
1895,	46.4	1901,	33.5
1896,	46.8	1902,	30.9
1897,	39.7	1903,	30.7
1898,	36.3	1904,	27.0
1899,	35.2	1905,	28.0
1900,	40.7	1906,	27.9

The death-rate from consumption was lower in 1906 than in any year of record, being 15.11, as against 16.01 in 1905, 16.05 in 1904, 15.66 in 1903 and 16.38 in 1902.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 541.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past twelve years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19, 19, 17.5, 16.7 and 16.8 in the twelve succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43, 45.7, 46.6 and 45.6 in the same years.

These all combined constituted the greater part of the total mortality in each of the thirteen years 1894–1906, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

TABLE I.

Population of Cities and Large Towns estimated for 1906.

REPORTING CITIES AND TOWNS.	Estimated Population for 1906.	REPORTING CITIES AND TOWNS.	Estimated Population for 1906.
Abington,	5,199	Athol,	7,224
Adams,	12,775	Attleborough,	12,995
Amesbury,	8,840	Beverly,	15,506
Amherst,	5,370	Blackstone,	5,799
Andover,	6,632	Boston,	602,527
Arlington,	9,881	Braintree,	7,058

TABLE I. — *Continued.*

REPORTING CITIES AND TOWNS.	Estimated Population for 1906.	REPORTING CITIES AND TOWNS.	Estimated Population for 1906.
Bridgewater,	6,943	Melrose,	14,578
Brockton,	49,510	Methuen,	8,909
Brookline,	24,206	Middleborough,	6,888
Cambridge,	98,583	Milford,	12,256
Chelsea,	37,968	Milton,	7,149
Chicopee,	20,402	Montague,	7,188
Clinton,	13,105	Natick,	9,633
Concord,	5,421	New Bedford,	77,006
Danvers,	9,167	Newburyport,	14,715
Dedham,	7,837	Newton,	37,511
Easthampton,	7,049	North Adams,	22,150
Easton,	4,923	Northampton,	20,231
Everett,	30,173	North Attleborough,	8,003
Fall River,	105,942	Northbridge,	7,473
Fitchburg,	33,327	Norwood,	6,981
Framingham,	11,598	Orange,	5,590
Franklin,	5,289	Palmer,	7,755
Gardner,	12,267	Peabody,	13,438
Gloucester,	26,011	Pittsfield,	25,703
Grafton,	5,088	Plymouth,	11,452
Great Barrington,	6,211	Quincy,	28,995
Greenfield,	9,402	Reading,	5,825
Haverhill,	37,962	Revere,	13,168
Hingham,	4,819	Rockland,	6,479
Holyoke,	50,824	Salem,	37,970
Hudson,	6,370	Saugus,	6,487
Hyde Park,	14,777	Somerville,	70,907
Ipswich,	5,314	Southbridge,	11,206
Lawrence,	76,000	South Hadley,	5,160
Leominster,	14,712	Spencer,	7,121
Lowell,	96,380	Springfield,	76,079
Lynn,	78,871	Stoneham,	6,359
Malden,	38,977	Stoughton,	6,062
Marblehead,	7,209	Swampscott,	5,260
Marlborough,	14,168	Taunton,	30,967
Maynard,	6,145	Wakefield,	10,476
Medford,	19,988	Waltham,	26,881

TABLE I. — *Concluded.*

REPORTING CITIES AND TOWNS.	Estimated Population for 1906.	REPORTING CITIES AND TOWNS.	Estimated Population for 1906.
Ware,	8,660	Whitman,	6,594
Watertown,	11,597	Williamstown,	4,425
Webster,	10,280	Winchendon,	6,119
Wellesley,	6,412	Winchester,	8,441
Westborough,	5,378	Winthrop,	7,229
Westfield,	13,887	Woburn,	14,432
West Springfield,	8,300	Worcester,	130,171
Weymouth,	11,638	Total,	2,636,318

The death-rate of Amesbury, Andover, Clinton, Concord, Gloucester, Hingham, Marblehead, Middleborough, North Adams, Palmer, Spencer, Taunton, Westborough and Williamstown was based on the population of 1905, these cities and towns having slightly decreased in population in the five years which elapsed between the census of 1900 and that of 1905.

While Lowell had fallen off between the two census years, it has, since 1905, made a gain by the annexation of a part of the town of Tewksbury, and this increase is included in the population given above.

TABLE II.

Total Deaths, Deaths by Sexes, and Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each with General Death-rates estimated for 1906.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1–2.	2–3.	3–4.	4–5.	5–10.	10–15.	15–20.	20–30.	30–40.	40–50.	50–60.	60–70.	70–80.	Over 80.	Age Unknown.	Rate per 1,000.
Abington,	83	41	42	–	7	13	2	1	1	1	3	1	2	7	5	5	6	6	20	10	–	15.96
Adams,	192	105	87	–	12	57	8	4	5	3	7	–	6	14	20	6	12	22	16	12	–	15.03
Amesbury,	144	80	64	–	10	18	5	3	–	1	2	5	4	5	8	9	17	29	20	18	–	16.29
Amherst,	67	35	32	–	2	7	1	–	–	–	–	1	1	4	7	–	8	14	12	12	–	12.47
Andover,	92	37	55	–	7	18	3	2	–	–	2	1	3	5	6	8	6	12	18	8	–	13.87
Arlington,	158	79	79	–	12	20	4	3	–	1	2	6	4	19	13	11	17	18	22	18	–	15.99
Athol,	138	60	78	–	4	14	4	1	–	1	3	2	2	7	9	10	18	21	18	28	–	19.10
Attleborough,	172	85	87	–	11	42	5	2	–	–	5	2	1	14	16	12	20	18	22	13	–	13.24
Beverly,	259	129	130	–	23	41	8	8	2	–	4	4	8	16	24	25	36	41	26	16	–	16.70
Blackstone,	106	57	49	–	8	25	3	–	–	–	1	1	–	9	14	6	7	11	18	11	–	18.28
Boston,[1]	11,411	5,965	5,446	–	658	2,468	525	232	118	96	263	154	237	883	1,180	1,230	1,275	1,249	965	536	–	17.18[2]
Braintree,	102	56	46	–	8	21	3	1	2	–	–	2	–	8	9	7	11	8	17	12	1	14.45
Bridgewater,[3]	73	36	37	–	–	15	1	–	–	–	1	2	2	4	4	5	2	11	12	14	–	10.51[2]
Brockton,	568	291	277	–	53	109	12	7	4	3	12	4	20	47	46	62	55	69	64	54	–	11.47
Brookline,	294	142	152	–	16	36	9	7	4	2	6	3	5	14	14	29	32	47	55	31	–	12.15
Cambridge,	1,561	783	778	–	118	347	82	36	13	13	37	29	38	100	130	129	174	171	151	111	–	15.83
Chelsea,[4]	689	418	271	–	54	141	33	16	7	5	17	8	10	46	47	47	77	103	91	41	–	14.96[2]
Chicopee,	340	155	185	–	34	139	28	5	6	1	9	3	10	14	19	16	20	42	16	11	1	16.66
Clinton,	159	81	78	–	12	34	6	1	1	–	8	1	7	17	12	13	16	22	14	7	–	12.13
Concord,	55	29	26	–	4	9	1	–	1	1	1	1	1	6	3	5	3	10	9	4	–	10.14
Danvers,[5]	116	61	55	–	11	21	6	2	–	–	1	–	3	12	6	11	11	19	15	9	–	12.65[2]
Dedham,	123	60	63	–	5	24	6	5	2	–	2	3	5	13	3	5	10	19	18	8	–	15.69
Easthampton,	88	44	44	–	7	19	2	3	2	1	6	–	3	1	5	10	7	11	11	7	–	12.48

Easton, ...	78	41	37	–	1	8	1	–	–	–	1	1	4	4	8	6	5	12	14	14	–	15.84
Everett, ...	347	173	174	–	41	80	18	14	8	2	6	1	8	12	23	33	37	36	36	33	–	11.50
Fall River, ...	2,073	1,061	1,012	–	646	700	130	298	61	88	144	137	120	145	125	72	27	18	5	3	–	19.57
Fitchburg, ...	512	266	246	–	37	159	36	10	2	2	9	4	14	32	28	33	40	46	57	40	–	15.36
Framingham, . . .	188	102	86	–	12	24	3	–	3	–	3	4	6	17	18	19	17	30	27	15	2	16.21
Franklin, ...	73	41	32	–	6	12	1	1	–	–	–	–	1	3	7	9	4	12	12	11	–	13.80
Gardner, ...	190	106	80	4	20	47	13	4	1	3	4	4	6	12	15	8	19	25	21	8	–	15.33
Gloucester, ...	355	188	167	–	29	69	11	6	6	3	23	5	14	20	35	27	29	40	46	19	2	13.65
Grafton, ...	94	43	51	–	3	11	1	1	2	1	–	1	2	10	6	7	18	12	15	7	–	18.47
Great Barrington, .	87	47	40	–	4	13	2	1	1	1	2	1	1	5	3	6	9	18	11	13	–	14.01
Greenfield, ...	142	70	72	–	13	22	7	3	–	2	2	1	2	10	11	4	10	25	23	20	–	15.11
Haverhill, ...	608	319	289	–	61	114	19	13	3	5	22	12	16	39	52	51	63	65	87	47	–	16.02
Hingham, ...	92	46	46	–	2	15	1	1	–	–	–	1	–	3	3	7	6	16	23	16	–	19.09
Holyoke, ...	899	469	430	–	70	305	53	21	16	8	29	8	12	58	67	56	80	86	64	36	–	17.69
Hudson, ...	82	43	39	–	7	15	4	1	2	1	3	1	2	3	6	11	10	7	6	9	1	12.87
Hyde Park, . . .	204	107	97	–	22	41	12	6	6	4	6	6	3	14	12	10	18	20	28	18	–	13.81
Ipswich, ...	82	43	39	–	7	16	3	–	–	–	1	–	4	4	7	8	4	14	15	6	–	15.43
Lawrence, ...	1,330	686	644	–	114	414	98	40	24	20	39	20	37	85	104	108	97	115	90	39	–	17.50
Leominster, . . .	255	127	128	–	16	41	14	4	2	2	8	2	8	18	31	21	20	27	34	19	4	17.33
Lowell, ...	1,919	945	974	–	128	544	108	46	33	23	39	33	50	116	173	170	172	211	129	72	–	19.91
Lynn, ...	1,140	585	555	–	114	220	33	11	10	7	20	16	31	81	95	115	119	162	137	83	–	14.45
Malden, ...	538	263	275	–	24	121	17	7	11	6	11	8	6	33	45	46	62	63	66	36	–	13.80
Marblehead, . . .	136	68	68	–	6	14	1	1	1	–	2	–	1	5	8	9	16	23	20	34	1	18.87
Marlborough, . . .	187	95	92	–	6	38	8	–	1	–	4	3	3	14	14	17	23	29	21	12	–	13.20
Maynard, ...	93	52	41	–	8	23	7	7	2	–	–	1	2	11	7	8	3	9	7	6	–	15.13
Medford, ...	260	136	124	–	19	31	8	2	1	3	3	3	–	13	13	24	35	43	51	30	–	13.01
Melrose, ...	189	84	105	–	8	22	4	1	1	2	4	4	4	11	13	20	21	35	24	22	1	12.96
Methuen, ...	175	108	67	–	8	36	8	3	1	3	5	1	3	5	9	16	16	27	42	–	–	19.64
Middleborough, . .	123	63	60	–	–	16	1	3	3	–	2	–	2	8	12	3	7	18	21	27	–	17.86
Milford, ...	238	121	115	2	14	46	15	8	4	1	4	3	3	12	30	26	15	27	29	13	2	19.42

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[1] Non-residents, 1,058, included. [2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.

[3] State Farm, deaths at, 82, not included. [4] Soldiers' Home and Marine and Naval Hospitals, 121 included. [5] Insane Asylum, 180 not included.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1–2.	2–3.	3–4.	4–5.	5–10.	10–15.	15–20.	20–30.	30–40.	40–50.	50–60.	60–70.	70–80.	Over 80.	Age Unknown.	Rate per 1,000.
Milton, ...	91	45	46	–	4	12	–	–	–	1	3	1	1	4	6	7	8	21	12	15	–	12.73
Montague, . . .	127	68	59	–	13	39	4	2	2	2	2	–	6	11	9	9	11	9	15	6	–	17.67
Natick, ...	145	73	72	–	4	15	4	1	1	1	3	1	2	13	11	13	22	19	31	8	–	15.05
New Bedford, . .	1,333	690	643	–	122	432	88	29	24	11	38	18	31	76	100	80	93	137	113	63	–	17.31
Newburyport, . .	341	176	165	–	15	57	8	2	3	1	4	7	7	30	19	22	51	38	70	7	15	23.17
Newton, ...	446	198	248	–	26	79	10	8	5	3	9	3	11	33	25	43	42	61	66	48	–	11.89
North Adams, . .	291	152	139	–	28	46	16	11	6	3	6	5	14	26	19	19	35	31	43	11	–	13.14
Northampton,[1] . .	356	180	176	–	14	45	6	8	4	2	7	4	3	17	32	31	40	51	64	42	–	13.89[2]
North Attleborough, .	100	46	54	–	15	19	3	3	–	–	2	2	1	2	8	10	10	14	19	7	–	12.50
Northbridge, . .	125	74	51	–	14	44	5	3	1	3	1	–	4	14	14	6	7	9	9	5	–	16.73
Norwood, . . .	90	44	46	–	10	25	3	1	1	1	1	3	3	2	5	5	9	12	10	9	–	12.89
Orange, ...	82	44	38	–	4	7	2	–	–	–	3	–	4	3	4	4	16	16	10	13	–	14.67
Palmer, ...	111	63	48	–	13	41	5	2	–	3	1	–	2	4	8	4	5	14	17	5	–	14.31
Peabody, . . .	199	88	111	–	14	37	3	6	2	1	4	3	2	11	12	22	22	33	24	17	–	14.81
Pittsfield, . . .	378	215	163	–	40	42	14	2	2	2	6	4	13	39	35	42	37	48	53	39	–	14.71
Plymouth, . . .	176	97	79	–	8	27	4	3	2	–	5	1	2	19	11	9	21	32	21	19	–	15.37
Quincy, ...	385	191	194	–	25	95	25	4	4	3	16	5	8	22	36	29	27	35	41	34	1	13.28
Reading, ...	78	34	44	–	1	10	–	2	1	–	1	2	1	5	6	5	11	8	13	13	–	13.39
Revere, ...	212	124	88	–	16	45	11	2	2	–	4	6	9	16	21	23	16	24	24	9	–	16.10
Rockland, . . .	104	43	61	–	3	13	2	1	1	–	–	1	1	5	8	12	19	13	18	10	–	16.05
Salem, ...	756	371	385	–	41	172	30	15	13	6	30	14	14	44	49	49	72	92	102	54	–	19.91
Saugus, ...	105	51	54	–	3	–	30	2	–	1	4	–	2	7	6	9	7	12	21	4	–	16.19
Somerville, . . .	1,004	481	523	–	77	183	48	17	17	7	20	14	11	60	77	74	103	154	125	94	–	14.16
Southbridge, . .	168	73	95	–	12	40	1	2	2	1	8	4	7	15	13	13	19	13	18	12	–	14.99
South Hadley, . .	66	28	38	–	7	17	3	–	1	–	3	1	–	5	5	3	10	7	9	2	–	12.79

Spencer, . . .	115	68	47	–	10	8	1	–	–	–	–	–	3	6	10	11	13	22	21	19	1	16.15
Springfield, . . .	1,136	595	541	–	69	212	42	19	16	8	26	19	23	103	88	117	108	146	125	84	–	14.93
Stoneham, . . .	119	52	67	–	8	12	1	2	–	–	3	1	1	10	12	7	11	23	22	14	–	18.71
Stoughton, . . .	88	36	52	–	3	17	2	–	–	–	1	–	–	6	4	8	8	16	17	9	–	14.52
Swampscott, . .	72	42	30	–	4	10	6	–	1	1	–	–	3	4	4	9	5	10	12	7	–	13.68
Taunton,[3] . . .	640	349	291	–	41	134	25	11	5	6	18	7	14	44	61	54	59	80	84	37	1	17.41[2]
Wakefield, . . .	134	76	58	–	8	23	1	1	–	1	2	–	5	7	7	10	21	21	17	18	–	12.79
Waltham, . . .	356	174	182	–	11	51	11	7	5	2	11	12	12	23	31	35	29	48	48	31	–	13.24
Ware, . . .	180	89	91	–	6	51	19	3	1	2	7	–	2	11	9	6	14	13	27	15	–	20.79
Watertown, . .	153	71	82	–	10	29	9	–	5	1	3	2	5	9	10	14	16	17	16	17	–	13.19
Webster, . . .	152	72	80	–	17	8	47	1	6	2	4	1	1	8	14	10	10	20	13	7	–	14.79
Wellesley, . . .	59	24	35	–	1	5	1	1	1	–	4	–	1	3	5	5	6	8	8	11	–	9.20
Westborough,[4] . .	166	96	70	–	2	7	–	–	–	1	1	1	4	9	13	19	26	30	31	24	–	15.62[2]
Westfield, . . .	215	101	114	–	11	40	6	4	–	1	7	1	5	12	23	18	15	36	26	20	1	15.48
West Springfield, .	110	59	51	–	14	26	2	2	–	1	4	–	2	7	10	4	14	18	15	5	–	13.25
Weymouth, . .	197	99	98	–	19	23	3	1	2	2	3	1	8	13	13	7	25	29	39	28	–	16.93
Whitman, . . .	91	49	39	3	5	14	3	1	1	–	3	–	6	5	6	12	10	4	13	10	3	13.80
Williamstown, . .	53	21	32	–	7	6	–	1	1	–	1	1	–	4	1	7	3	6	10	12	–	11.98
Winchendon, . .	92	40	52	–	5	16	9	1	1	1	3	1	2	6	7	4	9	10	12	10	–	15.04
Winchester, . .	85	40	45	–	4	20	4	–	–	1	2	–	1	4	4	8	6	12	15	7	1	10.07
Winthrop, . . .	99	41	58	–	4	6	5	2	3	–	3	–	–	4	13	14	12	12	15	8	2	13.69
Woburn, . . .	246	138	108	–	13	49	12	7	1	1	6	4	6	20	13	31	24	30	29	13	–	17.05
Worcester,[5] . . .	2,273	1,199	1,074	–	152	487	85	28	24	19	41	37	46	151	196	223	264	315	227	130	–	16.15[2]
	43,779	22,507	21,263	9	3,475	9,651	2,013	1,070	540	418	1,122	701	1,046	3,020	3,673	3,787	4,263	5,073	4,581	2,781	40	16.61

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[1] State Hospital, 75 included.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.

[3] Insane Asylum, 101 included.

[4] Insane Asylum, 82 included.

[5] Insane Hospital and Insane Asylum, 170 included.

TABLE III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each, 1906.

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Abington, . . .	2	–	1	–	3	3	–	2	1	–	–	–	–	9	2	10	1	10	15	8	6	–	–	7	3
Adams, . . .	17	–	1	2	4	–	3	2	–	–	–	1	12	–	3	10	3	20	9	3	3	–	5	–	94
Amesbury, . .	7	–	–	–	2	2	3	3	–	2	–	–	–	4	–	18	4	28	19	15	11	–	7	–	17
Amherst, . .	4	–	–	–	–	1	–	–	–	–	–	–	–	1	1	10	3	10	6	2	2	–	2	–	25
Andover, . .	10	–	–	–	–	–	2	–	–	–	–	–	–	–	–	9	6	17	1	1	6	–	6	–	34
Arlington, . .	15	–	–	1	3	–	2	1	–	–	–	–	2	–	–	13	5	16	–	12	7	1	6	–	74
Athol, . . .	11	–	–	–	2	–	3	–	–	1	–	–	–	–	4	11	–	16	27	6	14	1	2	–	40
Attleborough, . .	14	–	–	–	–	2	2	1	–	–	2	–	7	1	3	15	3	17	17	11	15	1	4	–	56
Beverly, . . .	18	–	–	–	3	4	2	1	–	–	–	–	5	–	1	29	10	33	21	6	20	2	17	1	84
Blackstone, . .	10	–	–	–	–	–	1	–	–	3	–	–	9	1	3	5	2	18	6	4	8	1	2	–	33
Boston, . . .	1,185	–	61	39	152	112	122	83	44	19	40	1	124	26	468	1,331	264	1,118	542	630	586	64	602	92	3,687
Braintree, . .	5	–	–	–	–	–	–	4	–	–	3	–	4	–	1	12	4	14	10	4	2	–	7	1	31
Bridgewater, . .	5	–	–	–	–	–	–	–	–	–	1	–	–	–	3	7	–	7	–	6	5	–	3	8	28
Brockton, . .	61	–	–	1	3	10	8	10	2	8	2	1	9	4	–	56	9	57	43	31	42	7	12	1	191
Brookline, . .	17	–	1	2	4	7	1	–	–	–	1	–	–	2	3	27	9	70	29	22	19	–	6	1	73
Cambridge, . .	157	–	5	6	26	45	19	20	1	1	3	–	34	3	65	165	41	180	181	83	82	8	61	68	306
Chelsea, . . .	63	–	1	–	6	7	7	7	1	–	–	2	18	2	11	72	7	77	46	42	34	1	26	–	259
Chicopee, . .	25	–	–	7	2	9	1	1	–	–	1	–	31	1	5	39	7	18	13	9	15	–	7	3	146
Clinton, . . .	14	–	–	–	1	2	–	2	–	–	1	–	2	–	1	23	3	12	1	9	6	1	6	–	75
Concord, . .	2	–	–	–	3	–	–	2	–	–	3	–	1	–	–	4	–	11	7	4	5	–	2	–	11
Danvers, . .	9	–	–	–	1	3	2	3	–	–	–	–	4	–	–	14	–	19	2	7	14	3	5	–	30
Dedham, . .	7	–	–	–	3	3	–	1	–	–	–	–	3	2	9	7	2	20	15	8	6	1	11	–	25
Easthampton, . .	6	–	–	–	–	1	2	1	–	–	–	–	7	–	3	4	3	10	3	3	1	2	2	–	40
Easton, . . .	9	–	–	1	–	1	–	1	–	–	–	–	–	1	–	9	–	4	11	9	5	1	3	–	23
Everett, . . .	32	–	–	–	12	7	5	3	–	–	4	–	7	–	4	28	15	36	2	8	21	4	5	–	152
Fall River, . .	141	–	5	5	23	12	9	10	1	2	11	1	232	13	33	164	125	97	316	67	35	4	65	15	687

Fitchburg,	40	-	-	-	6	6	1	-	1	-	-	-	28	2	4	58	14	49	-	13	15	5	26	12	230
Framingham,	13	-	-	-	1	1	-	1	-	1	2	-	2	3	-	22	3	15	5	17	7	1	22	1	70
Franklin,	4	-	-	-	1	-	-	-	-	3	1	-	1	-	1	4	-	14	17	12	3	1	3	-	8
Gardner,	14	-	1	-	1	-	1	1	1	-	-	-	7	-	-	26	1	17	25	11	5	-	7	2	70
Gloucester,	19	-	-	-	17	1	3	1	-	-	1	-	5	-	-	19	7	26	26	22	13	-	14	1	180
Grafton,	5	-	-	1	-	-	-	1	-	-	-	-	5	-	2	13	2	9	-	3	4	1	6	-	42
Great Barrington,	7	-	-	-	-	-	-	-	-	1	-	-	2	-	-	7	2	13	14	7	5	1	2	-	26
Greenfield,	9	-	-	-	2	1	1	8	-	-	-	-	1	2	4	18	-	17	9	11	8	2	5	-	42
Haverhill,	55	-	-	6	19	5	10	8	2	-	4	-	25	-	3	54	8	71	33	25	52	11	28	3	185
Hingham,	8	-	-	-	-	-	1	2	2	-	2	1	-	-	5	3	2	12	18	2	2	2	-	7	23
Holyoke,	76	-	2	4	19	23	4	2	4	1	4	-	42	3	12	107	17	52	19	66	30	6	29	-	377
Hudson,	6	-	1	-	4	2	-	4	-	-	2	-	-	1	-	3	3	12	8	3	7	1	1	-	24
Hyde Park,	18	-	-	1	8	5	2	1	-	1	-	-	9	2	-	19	5	18	12	9	11	2	9	-	72
Ipswich,	13	-	-	-	-	-	2	-	-	-	-	-	3	-	-	13	1	14	4	2	6	2	8	7	7
Lawrence,	114	-	11	2	16	33	16	25	4	4	2	1	108	8	14	176	26	107	107	56	32	7	53	131	276
Leominster,	23	-	4	-	12	-	2	-	-	1	-	-	2	2	1	33	3	34	19	18	20	3	8	1	69
Lowell,	161	-	13	3	40	6	7	39	3	2	2	-	93	4	159	228	75	190	209	110	70	9	69	2	425
Lynn,	79	-	1	6	6	8	12	8	3	-	2	-	32	2	9	129	23	137	120	66	62	7	38	7	383
Malden,	54	-	1	-	10	4	3	-	-	-	-	-	13	1	2	62	15	81	67	38	37	7	5	-	133
Marblehead,	2	-	-	2	-	2	2	-	-	-	-	-	2	-	-	8	2	23	-	9	16	4	1	-	63
Marlborough,	23	-	2	1	1	-	-	-	2	-	-	-	8	-	-	9	1	32	14	13	12	1	2	2	64
Maynard,	7	-	1	-	3	-	1	1	-	-	-	-	7	1	1	9	3	6	17	3	2	-	4	-	27
Medford,	6	-	-	-	2	1	4	1	-	-	-	-	1	-	-	26	9	29	-	25	26	-	12	-	118
Melrose,	21	-	2	-	3	1	3	2	-	-	-	-	2	-	2	13	2	27	32	12	18	1	4	16	28
Methuen,	18	-	-	1	2	-	6	15	2	-	-	-	10	-	8	24	10	15	10	8	4	-	6	-	32
Middleborough,	10	-	-	-	3	-	-	2	1	1	-	-	3	3	2	9	3	27	7	4	4	2	4	-	38
Milford,	22	-	1	-	3	1	5	10	-	-	-	-	5	-	16	43	5	26	5	13	13	4	4	-	62
Milton,	12	-	1	-	-	-	1	-	1	-	1	-	-	-	-	10	3	9	3	1	1	-	3	-	45
Montague,	12	-	-	-	2	-	1	5	-	-	-	-	9	-	-	8	6	18	-	-	1	-	10	-	55
Natick,	9	-	-	-	2	-	3	1	1	-	-	-	4	-	-	9	5	21	-	-	9	-	3	-	78
New Bedford,	124	-	1	3	27	3	7	4	-	-	2	-	85	4	2	122	47	127	82	49	51	8	1	-	584
Newburyport,	31	-	1	1	1	2	8	4	-	-	1	-	5	2	2	41	1	25	3	2	10	1	1	-	199
Newton,	22	-	2	-	5	1	3	3	1	-	3	-	6	4	13	35	7	54	43	28	20	-	12	-	184
North Adams,	25	-	-	2	4	-	6	1	-	1	-	-	11	1	4	34	11	17	11	3	14	1	13	-	132
Northampton,	25	-	-	1	7	-	3	1	3	-	1	-	8	-	6	31	7	48	46	20	18	2	10	4	115
North Attleborough,	10	-	-	-	2	1	-	-	1	1	-	1	3	-	2	14	1	8	15	8	2	-	2	-	29

TABLE III. — *Concluded.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Northbridge,	14	–	1	–	2	1	2	4	–	–	1	1	11	1	7	17	1	16	2	9	6	–	6	–	23
Norwood,	8	–	–	1	–	2	–	1	2	–	–	–	10	–	–	4	3	14	10	6	6	–	4	5	14
Orange,	5	–	–	–	–	–	3	1	1	–	1	–	2	–	1	6	–	16	12	9	1	2	1	–	21
Palmer,	11	–	–	–	1	1	–	–	–	–	–	–	9	3	3	16	2	15	14	3	4	–	4	1	24
Peabody,	18	–	–	1	2	1	2	3	3	–	–	–	6	–	1	20	11	17	26	16	10	1	7	–	54
Pittsfield,	48	–	–	–	8	–	3	5	–	1	–	–	19	–	1	40	6	66	25	32	21	6	27	42	27
Plymouth,	19	–	1	–	–	2	1	2	–	–	1	–	4	1	–	17	4	37	24	8	11	3	8	–	30
Quincy,	47	–	1	–	9	4	1	10	2	2	–	1	11	2	17	45	12	55	25	13	20	2	17	–	88
Reading,	5	–	–	–	2	–	1	3	–	–	–	–	1	–	–	5	1	6	12	3	4	–	3	–	32
Revere,	16	–	–	–	1	2	4	9	–	–	–	–	5	2	6	17	7	12	3	20	15	2	6	–	85
Rockland,	14	–	–	–	1	2	2	–	–	–	–	–	3	2	–	3	4	13	3	6	5	–	2	9	35
Salem,	83	–	1	2	17	25	13	2	7	–	3	–	26	1	9	59	25	51	45	38	33	4	27	–	285
Saugus,	11	–	–	–	–	–	2	–	–	–	–	–	1	–	–	18	2	13	1	3	1	–	4	–	49
Somerville,	95	–	2	1	15	11	11	15	2	–	1	–	18	3	5	133	30	81	59	78	75	1	30	–	338
Southbridge,	18	–	–	–	4	–	2	2	–	–	–	–	4	–	2	10	3	17	15	8	4	2	11	33	33
South Hadley,	7	–	–	–	2	–	1	4	–	1	–	–	1	–	–	10	1	9	5	2	3	–	4	–	16
Spencer,	8	–	–	–	–	1	2	1	1	–	–	–	–	–	–	11	2	22	6	5	7	–	1	–	48
Springfield,	94	–	4	4	23	21	17	4	3	9	4	–	31	2	34	109	19	102	82	104	66	12	68	15	307
Stoneham,	16	–	–	–	–	1	2	–	–	–	–	–	3	1	1	8	2	13	15	16	9	–	5	–	27
Stoughton,	5	–	–	–	1	1	–	–	–	–	2	–	4	–	–	8	1	14	–	4	7	1	2	–	38
Swampscott,	4	–	–	–	1	1	1	–	1	–	1	–	–	1	–	19	–	8	1	9	1	–	4	–	20
Taunton,	68	–	2	–	2	9	9	11	–	1	4	2	10	5	36	74	21	53	5	25	18	2	3	–	280
Wakefield,	21	–	1	1	2	1	–	2	–	–	–	–	1	–	–	7	5	27	11	9	9	–	1	–	36
Waltham,	33	–	2	1	11	–	6	1	1	–	2	–	1	2	4	51	13	38	58	20	15	2	11	–	84
Ware,	11	–	–	–	6	2	1	–	–	–	–	–	15	2	–	22	6	15	20	–	8	–	4	–	68

Watertown,	11	–	–	–	1	2	1	3	–	1	–	–	2	1	–	16	4	26	18	11	7	1	7	8	32
Webster,	11	–	3	–	3	1	2	3	–	–	–	2	10	–	13	13	4	11	14	6	2	–	2	–	51
Wellesley,	4	–	–	–	2	–	–	2	–	–	–	–	–	–	1	5	–	7	9	3	9	–	3	1	13
Westborough,	21	–	–	1	–	–	1	–	–	–	–	–	2	–	–	21	3	27	64	10	4	–	3	1	8
Westfield,	13	–	1	1	4	–	3	–	–	–	2	–	2	1	–	15	1	30	6	15	15	2	6	–	98
West Springfield,	10	–	–	–	2	1	1	5	–	–	–	–	5	1	3	13	1	8	7	8	1	2	2	–	40
Weymouth,	25	–	–	–	1	1	1	5	–	–	2	–	6	2	–	17	6	34	23	8	15	1	5	7	38
Whitman,	9	–	1	–	1	4	–	–	1	–	–	–	3	1	1	4	–	14	9	6	2	–	4	–	31
Williamstown,	7	–	–	–	1	–	1	–	–	–	1	–	–	1	–	6	1	7	4	4	2	–	–	–	17
Winchendon,	5	–	–	–	–	3	1	–	–	–	1	–	–	1	7	9	3	8	11	1	5	2	1	–	33
Winchester,	10	–	–	–	1	3	–	1	–	–	1	–	–	1	–	15	–	7	8	3	5	2	1	2	25
Winthrop,	5	–	–	–	2	–	2	–	–	–	–	–	5	–	1	13	1	14	15	21	10	–	6	–	4
Woburn,	35	–	–	1	–	1	1	9	1	–	1	–	5	1	–	21	4	32	22	14	9	1	8	–	80
Worcester,	196	–	13	2	48	11	15	52	6	7	5	1	181	–	32	244	41	193	254	104	119	18	51	6	673
	3,984	–	153	114	658	453	432	469	113	75	135	16	1,475	153	1,082	4,672	1,106	4,483	3,285	2,359	2,144	263	1,658	523	13,924

	Homicide.
Beverly,	1
Boston,	18
Cambridge,	1
Everett,	2
Fitchburg,	2
Framingham,	1
Lawrence,	1
Methuen,	4
Plymouth,	3
Quincy,	1
Springfield,	1
Watertown,	1
Williamstown,	1
Winchendon,	1
	38

	Hydrophobia.
Amesbury,	1
Attleborough,	1
Beverly,	1
Greenfield,	1
Haverhill,	1
Springfield,	1
	6

	Tetanus.
Amesbury,	1
Pittsfield,	1
	2

	Glanders and Farcy.
Boston,	1

	Malignant Pustule.
Greenfield,	1

	Anthrax.
Webster,	1

	Trichinosis.
Worcester,	1

TABLE IV.

Deaths from Specified Causes, 1906, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1902–1906), Deaths per 1,000 from All Causes, 1902–06.

CAUSES OF DEATH.	Deaths 1906.	MORTALITY PER 10,000 OF THE POPULATION.					DEATHS PER 1,000 FROM ALL CAUSES.				
		1906.	1905.	1904.	1903.	1902.	1906.	1905.	1904.	1903.	1902.
Consumption, . . .	3,984	15.11	16.01	16.05	15.66	16.38	91.00	95.46	103.76	97.06	101.06
Smallpox, . . .	–	–	0.008	0.03	0.08	1.12	–	0.046	0.20	0.51	6.89
Measles, ...	153	0.58	0.61	0.63	0.69	0.92	3.49	3.62	4.04	4.27	5.66
Scarlet fever, . . .	114	0.43	0.43	0.43	1.75	1.13	2.60	2.56	2.77	10.85	6.99
Diphtheria and croup, .	658	2.50	2.20	2.38	2.94	3.22	15.03	13.13	15.39	18.20	19.84
Whooping cough, . .	453	1.72	0.64	0.45	1.64	0.96	10.35	3.78	2.92	10.19	5.96
Typhoid fever, . .	432	1.64	1.87	1.59	1.81	1.88	9.87	11.15	10.29	11.24	11.59
Cerebro-spinal meningitis.	469	1.78	2.36	1.13	1.33	1.39	10.71	14.10	7.28	8.23	8.60
Erysipelas, . . .	113	0.43	0.52	0.58	0.35	0.44	2.58	3.11	3.77	2.16	2.74
Puerperal fever, . .	75	0.28	0.34	0.27	0.33	0.32	1.71	2.00	1.72	2.04	1.98
Influenza, . . .	135	0.51	1.22	0.77	1.06	0.43	3.08	7.26	4.97	6.60	2.64
Malarial fever, . .	16	0.06	0.13	0.11	0.16	0.15	0.36	0.78	0.74	1.02	0.94
Cholera infantum, . .	1,475	5.59	5.88	5.21	5.89	6.05	33.70	35.05	33.67	36.50	37.36
Dysentery, . . .	153	0.58	0.62	0.63	0.62	0.70	3.49	3.71	4.07	3.88	4.35
Diarrhœa and cholera morbus.	1,082	4.10	4.15	3.59	3.29	3.71	24.72	24.74	23.21	20.36	22.88
Pneumonia, . . .	4,672	17.72	17.75	15.85	16.48	16.07	106.72	105.85	102.46	102.11	99.21
Bronchitis, . . .	1,106	4.19	4.31	4.23	4.55	4.69	25.27	25.69	27.37	28.17	28.96
Diseases of the heart, .	4,483	17.00	17.36	16.21	15.25	15.66	102.40	103.50	104.79	94.52	96.40
Diseases of the brain and spinal cord.	3,285	12.46	14.74	12.56	11.15	12.17	75.03	87.88	81.24	69.10	75.12
Diseases of the kidneys,	2,359	8.95	9.01	8.24	8.45	7.38	53.90	53.75	53.30	52.36	45.57
Cancer, ...	2,144	8.13	7.97	7.34	7.05	6.91	48.98	47.55	47.49	43.70	42.66
Suicide, ...	263	1.00	1.09	1.03	1.05	1.02	6.01	6.52	6.69	6.50	6.30
Accident, ...	1,658	6.29	5.88	5.14	5.43	5.40	37.87	35.06	33.25	33.66	33.31
Unknown or ill-defined causes.	523	1.98	2.00	1.70	1.91	1.64	11.95	11.96	10.98	11.84	10.11
All causes, . .	43,779	166.10	167.67	154.65	161.32	162.07	–	–	–	–	–

HEALTH OF TOWNS.

HEALTH OF TOWNS.

The following digest consists chiefly of extracts from the annual reports of the boards of health of cities and towns for the year 1906, illustrating the character and extent of the sanitary work performed by the local authorities.

Forty-two cases of smallpox were reported for the year 1906, as against 44 for the year 1905, 100 for the year 1904 and 417 for the year 1903, showing a marked decrease in the prevalence of this disease.

There was an increase in the number of reported cases of scarlet fever for the year 1906, as compared with the number reported for 1905. In Lawrence there were 62 cases and 2 deaths, the fatality being 3.2 per cent., as against a fatality of 10.5 in 1905. In Boston there were 1,341 reported cases and 29 deaths, a fatality of 2 per cent.; in Cambridge, 166 cases with 6 deaths, the fatality being 3.6 per cent.; in Fall River, 83 cases with 5 deaths, the fatality being 6 per cent.; in Somerville the fatality was 0.6 per cent.; in Worcester, 1.4 per cent.; in Lowell, 3.4 per cent.; in Springfield, 1.5 per cent. In Newton there were 117 cases, with no deaths.

The following numerical statement of bacteriological work performed by local boards of health is also taken from the annual reports of those boards for the year 1906: —

Bacteriological Work performed by Local Boards of Health and by the State Board of Health, 1906.

	Diphtheria Cultures.	Tuberculosis.	Typhoid Fever.	Malaria.
Agawam,	3	-	-	-
Barre,	4	-	-	-
Boston,[1]	12,061	4,255	1,630	191
Brockton,[2]	344	334	180	83
Brookline,	721	154	79	28
Cambridge,[3]	8,583	392	311	-
Chester,	3	-	-	-
East Longmeadow,	4	-	-	-
Fall River,[4]	145	-	87	-

[1] Glanders, 258; other diseases, 450.

[2] Other diseases, 81.

[3] Other diseases, 9.

[4] Other diseases, 1.

Bacteriological Work performed by Local Boards of Health and by the State Board of Health, 1906 — Concluded.

	Diphtheria Cultures.	Tuberculosis.	Typhoid Fever.	Malaria.
Fitchburg,	123	124	38	–
Granville,	4	–	–	–
Greenfield,	22	–	–	–
Hardwick,	12	–	–	–
Haverhill,[1]	195	–	–	–
Holyoke,	308	–	–	–
Huntington,	3	–	–	–
Leominster,[2]	448	111	51	–
Longmeadow,	6	–	–	–
Lowell,[3]	1,759	415	165	4
Lynn,	894	71 [4]	–	–
Monson,	2	–	–	–
Montague,	2	–	–	–
New Bedford,	546	136	–	–
Newton,	433	25	82	–
Northampton,[5]	216	96	–	–
Palmer,	13	–	–	–
Somerville,	968	175	94	–
South Hadley,	1	–	–	–
Springfield,	1,707	139	60	–
Waltham,	1,934	23	30	4
Ware,	71	–	–	–
Westfield,	8	–	–	–
West Springfield,	12	–	–	–
Wilbraham,	4	–	–	–
Worcester,	5,148	468	–	–
State Board of Health,	4,646	1,705	705	31

[1] April 16 to Dec. 31, 1906.
[2] Other diseases, 26.
[3] Other diseases, 8.
[4] July 1 to Dec. 31, 1906.
[5] Other diseases, 6.

AMESBURY.

Early in the year, the board of health, in conjunction with members of the Amesbury Medical Association, formulated rules in regard to quarantine. These rules have been printed, and whenever a case of contagious disease is reported, a copy is left at the house of the patient.

ARLINGTON.

The board of health of Arlington has adjudged the diseases known as scarlet fever, measles, typhoid fever, diphtheria, smallpox, membranous croup, cholera, yellow fever, typhus fever, cerebro-spinal meningitis, hydrophobia, malignant pustule, leprosy, trichinosis, tuberculosis and ophthalmia of the newly born as infectious or contagious, and dangerous to the public health and safety within the meaning of the statutes. Physicians are required to report immediately to the board every case of either of these diseases coming under their care, and postal cards conveniently printed and addressed are supplied to them for this purpose. On receipt of a card from a physician, the superintendent of schools, principal of high school, trustees of Robbins Library and medical inspector of schools are notified.

Fumigation. — A more thorough system of fumigation has been adopted, and on the recovery or death of each case of diphtheria, scarlet fever and tuberculosis the board attends immediately to the fumigation of the premises.

Circulars of Information. — Circulars giving instruction for the general care of patients, and suggesting means for preventing the spread of diphtheria, scarlet fever, typhoid fever, measles and consumption or tuberculosis have been printed, to be sent to families in which any of said diseases occur.

Regulations. — A new set of plumbing and drainage regulations has been adopted. They have been prepared by the board under the advice of the best obtainable authorities on these subjects, and were adopted after having been submitted to the secretary of the State Board of Health.

ATHOL.

The collection of garbage, recommended by the board last year, has been a great success, and has been carried out much to the satisfaction of the public.

The board has inspected the bakeries, candy kitchens, schoolhouses, slaughterhouses, etc., and made such recommendations as seemed wise. It specially recommends that the town comply with the State law, and appoint a medical inspector for the public schools.

BEVERLY.

The regular inspection of bakeries, as prescribed by law, has been made, and copies of the statutes relating thereto have been posted in the bakeries throughout the city. At the last inspection the majority were found to be in good condition, while in some the sanitary conditions were bad and changes were ordered.

The board recommends the building of a hospital for the care of contagious diseases, especially for the care of diphtheria and scarlet fever.

Boston.

The total number of deaths for the year was 11,411, an increase over the previous year of 404 deaths. The estimated population, in the middle of the year, is 602,526. The death-rate for the year, as calculated on this population, is 18.94 per 1,000 inhabitants. This rate was greater by 0.92 than that of the previous year, but lower by 0.45 than the average of the previous ten years. There were 2,119 deaths from infectious diseases, including consumption, a decrease of 42 deaths. There were 20 more deaths from diphtheria and croup than in 1905, and a proportionate increase in the number of cases. The percentage of deaths to the number of cases of diphtheria reported was 7.00, as against 8.52 per cent. the preceding year. There were 39 deaths from scarlatina, 5 less deaths than in the preceding year, and 60 deaths less than the average for the ten previous years. Typhoid fever caused 122 deaths during the year, 5 more deaths than the preceding year. Fifty-eight of the deaths from this cause occurred during the months of August, September and October, and 73 of the whole number died between the ages of twenty and forty years.

There were 61 deaths from measles during the year. The number of deaths of children under five years of age was 3,439, compared with 3,024 for the previous year, showing an increase of 415 deaths. The respiratory diseases caused 24 per cent. of the mortality for the past year.

Consumption. — The death-rate from consumption in Boston has steadily decreased for many years, and particularly so during the last twenty years, notwithstanding the serious lack of hospital accommodations. The highest recorded death-rate from this disease in Boston occurred in 1853, when it amounted to 48.16 in each 10,000 of the population, and the average annual death-rate in each 10,000 of the population from this disease from 1850 to 1855 was 47.36.

The average death-rate from 1880 to 1885 was	40.91
The average death-rate from 1885 to 1890 was	35.44
The average death-rate from 1890 to 1895 was	28.88
The average death-rate from 1895 to 1900 was	24.05
The average death-rate from 1900 to 1905 was	21.75
And the death-rate for 1906 was	19.67

Manufacture and Sale of Ice Cream. — Owing to the frequent and sometimes alarming illnesses immediately following the eating of ice cream. the board of health became convinced that this article of food should be better protected in its manufacture and subsequent care, and on Aug. 4, 1906. promulgated a regulation for the manufacture, sale and care of ice cream.

Schoolhouses and School Children. — Many changes have taken place in recent years for the sanitary improvement of the schoolhouses and the physical welfare of the school children. This has been accomplished in part by the better construction and care of the schoolhouses and their appurtenances, and in part by a closer observation and inspection of the school children by teachers and physicians.

The proper seating of children has been largely secured by the action of the medical profession and the school committee. But, while the schoolhouse conditions have been greatly improved, there is still much to be looked for. Some of the schoolhouses should be abandoned, and extensive alterations should be made in others. Additional houses are needed, and a more liberal allotment of grounds should be given to many already in use.

The board has also added to the former duties of the medical inspectors of schools that of ascertaining the condition, isolation and means for prevention in all cases of typhoid fever and consumption. The extent of this medical service in the schools is dependent principally upon the observation and care used by the teachers in detecting and reporting all cases of illness and defects among the children to the visiting physician. The best results from the medical inspectors' work in the schools will be obtained only when nurses are employed to aid the teacher in finding the sick and the school physician in securing their treatment in the home and in the dispensary. The board is gratified to see that the services of nurses are fairly assured.

Bacteriological Laboratory. — The total number of routine bacteriological examinations made between Feb. 1, 1906, and Feb. 1, 1907, was 23,850. Of these, 18,845 were diagnoses and 5,005 were milk examinations.

The total number of routine examinations made during the year exceeds that of any other year by over 2,500. The number of diphtheria examinations exceeds that of any year except 1900, when diphtheria was very prevalent. The number of tuberculosis examinations continues to increase yearly. All other totals show an increase, with the exception of the milk examinations, which are limited in number by the nature of the tests.

Special Examinations. — Special examinations during the past year have included examinations for the organisms causing influenza, pneumonia, gonorrhœa, paratyphoid, actinomycosis, xerosis of conjunctiva, syphilis (*s. pallida*) and leprosy.

Tests have also been made for malaria, rabies, glanders, ophthalmia, virulence tests of pus, urine, spinal and pleuritic fluid and fæces for the organism of tuberculosis, and tests for ptomaine poisoning and of typhoid urine for the typhoid bacillus.

Bacteriological Examination of Milk. — During the year, 5,005 examinations have been made of samples of milk for bacterial content, the presence of pus and pus-producing organisms.

Special Investigations. — The following investigations, inspections and analyses have been made at the request of the board: —

Pollution of shellfish by sewage.

An investigation of the amount of danger of infection from the indiscriminate use of mouth-pieces attached to lung-testing machines in penny amusement resorts.

Effect of automobile cylinder oil on asphalt pavements.

Disinfectants.

Bacteriological examination of ice cream and hokey pokey.

Drawn *versus* undrawn fowl.

Bacteriological tests of drinking water.

Miscellaneous tests.

An attempt has been made to stop the use of milk vessels, which had become much too common, as containers for foreign substances. Copies of the law relating to the misuse of cans were mailed early in the summer to every licensed and registered milk dealer in the city. This had a marked effect in lessening the evil, but the subject still demands attention. The section of the law on misuse of milk cans applicable to milkmen, and which aims to prevent distribution of milk in receptacles belonging to another firm or corporation, has also been given attention.

The bacteriological examination of milk has been continued, and improvement in the quality of milk found at the contractors' cars is noted. This is evidence that the campaign of education for greater care in the production and handling of milk, although a task of large magnitude, is slowly bearing fruit. The results are surprising, in view of the fact that 1906 was exceptional from the standpoint of an insufficient ice crop, and many producers were without means to properly cool their milk during the warm months of the year. In all, 864 warnings were issued upon samples containing an excess of bacteria or streptococci, pus and streptococci, or pus: of these, 272 were sent to contractors and by the latter were immediately forwarded to the producer.

This decrease in percentage of infected milk is gratifying, and no doubt attributable to the persistent exclusion of milk of this character from that permitted to enter the city. This result has not been attained without grumbling and protest, but as none of the objectors have been willing to admit that they would knowingly consume milk thus infected, but little value could be attached to the protestations.

Reports upon the samples in which pus and streptococci were found were sent to those from whom the samples were obtained. A large percentage of these warnings was issued to contractors and by them forwarded to producers in the country. In addition, where these infected milks were procured from the contractor, the latter was immediately notified to stop bringing the product of these dairies to this city until the source of trouble was located and eliminated. This notification in most instances has met with cheerful compliance.

During the warm months of the year many temperature tests were made. These included tests at the trains as they arrived from the country, and of milk upon wagons and in shops as it was being supplied to customers. Throughout the year all samples taken for bacteriological examination are tested for temperature. A gradual awakening to the need of keeping milk cold is noted, but it was found necessary to issue 591 warnings; 320 of these went to contractors, and they in turn forwarded these notices to producers. In some instances where repeated warnings failed to bring about the desired result prosecutions were deemed necessary.

The consensus of opinion with contractors is that the bacteriological examination of milk has already proved beneficial.

The board calls attention to the increasing sale of renovated butter and oleomargarine, and to the numerous evasions of the law requiring the labelling of retail packages.

In accordance with instructions contained in a circular issued by the mayor relative to the prevention and spread of tuberculosis in municipal buildings, offices and workshops, the board of health appointed from its employees three "sanitary boards," with instructions to make a thorough sanitary inspection of the public buildings and workshops under the various city departments. On completion of the work, detailed reports were made and placed on file.

The board also calls attention to the existing bad conditions at Fort Hill Wharf and at Stony Brook. It has passed regulations relative to the city dumping grounds, and has made recommendations relative to the establishing of small crematories for the treatment of refuse and waste material.

BRIDGEWATER.

The health of the town has been far above the average for the past year. With the exception of an epidemic of whooping cough of a mild type, mostly during the summer months, there have been few cases of contagious diseases. Three scattered and mild cases of diphtheria, 5 of scarlet fever and 2 of typhoid fever were reported.

On account of the change in the public schools for 1906, the method of quarantining contagious diseases will be modified, and the wage-earners in a household where contagious diseases exist may follow their usual occupation, when, in the opinion of the board of health, the public health will not be endangered.

BROCKTON.

The death-rate of Brockton for the year 1906 was 11.36, and the number of deaths from contagious diseases was unusually low, being but 1 from scarlet fever, 3 from diphtheria, measles none, and from typhoid fever 8. The board has this year past adopted a system whereby contagious diseases are tabulated in a manner which enables it to keep a record of each case, and, from and through that record, trace the case to its origin, thereby removing the contagium which might otherwise continue to spread disease broadcast. Especially is this system of great help in tracing typhoid fever cases.

Milk Inspection. — During the year the board has taken up the work of inspection of milk, milk farms and dairies, and regulations for the production, care and sale of milk have been adopted. Nine dairies have been visited, and the milk of 126 cows collected and examined, with the result of temporarily quarantining 10 animals.

When starting the work of inspection, a survey of the methods in vogue among the various cities engaged in the work made it apparent that the technique as developed in the bacteriological laboratory of the Boston health department presented features most in accordance with the needs of the city of Brockton, and the apparatus purchased was, therefore, largely patterned after that in use there.

In this work of inspection of dairy farms such changes as the inspectors have found necessary to recommend have almost invariably met with ready compliance from the owners.

Laboratory Work. — The amount of work done for the board at the laboratory the past year exceeds that of 1905 by 41 per cent., and nearly doubles the work done in 1904, which indicates better than anything else the value of the bacteriological work.

Tuberculosis. — Complying with a request from the Plymouth County District Medical Society, the board has added tuberculosis to the list of diseases to be reported.

BROOKLINE.

Medical Inspection. — The systematic medical inspection, under the direction of the health department, of the pupils of the public schools and of the parochial school, more fully referred to in last year's report, was continued throughout the school year.

Hygienic drinking fountains have been put into all of the school buildings, the corridor of the town hall, and also on three playgrounds close to public schools, thus removing the chance of contracting disease from infected drinking cups.

Arrangements were made and carried out the past year for an examination by specialists of the eyes, ears, throats, noses and teeth of most of the pupils of the Pierce School, the town's largest and most representative school. No appropriation had been made by either the health department or school department for physical examinations of this kind, and the specialists who consented to do this important work served without remuneration. Interesting and valuable reports were prepared on the results of the investigation.

Barber Shops. — In July, after careful inquiry and some consultation with representative owners of barber shops, the board decided that certain regulations should be provided for the protection of the thousands of persons who constantly patronize these shops. An order was passed, and copies of it in the form of a placard were printed, and posted in plain view in every barber shop. Since these rules became operative, two inspections have been made of all such shops in the town. In the matter of cleanliness, the condition of all the shops was fairly satisfactory. The shop owners, most of them, appear to be alive to the fact that the board will be seriously handicapped in its efforts to check the spread of preventable diseases unless aided by intelligent co-operation on their part. The board believes that they are making an earnest effort to supplement its work, and that the end of the coming year will witness a measure of improvement in almost every such shop in town.

Bacteriological Laboratory. — The routine work of the laboratory has been of the same character as during the preceding years. It has consisted of: —

(1) The examination of cultures and swabs from suspected cases of diphtheria.

(2) The examination of sputum for the early detection of cases of pulmonary tuberculosis.

(3) The test for the presence of the typhoid, or so-called Widal's reaction.

(4) The examination of blood for the presence of the *plasmodium malariæ.*

All of the above examinations are made without charge for residents of Brookline. For a small fee, analyses of urine and other microscopical and chemical examinations which aid in the diagnosis of non-contagious diseases are made for the physicians of the town.

In order to secure an earlier diagnosis of some cases of diphtheria than is possible by means of cultures which are incubated for twelve hours, the laboratory now offers to make examinations directly from cotton swabs which have been wiped over suspected areas of the throat.

The laboratory is called upon more and more each year by citizens for information and advice on questions of hygiene and sanitation, and especially in regard to the danger of contagion in different cases and the need of disinfection.

The bacteriologist would again bring to the attention of the board the question of making bacteriological examinations of milk in the laboratory. Such examinations are made by the Boston board of health, and have proved of value in securing an improvement in the milk supply.

Bakeries. — In accordance with the Revised Laws, the various bakeries of the town have been twice inspected during the year. In all cases their general condition as regards cleanliness was found to be very fair.

Milk Inspection. — Nearly all the premises of milk producers supplying Brookline, within a radius of twenty-five miles, have been inspected during the year. Some 60 of the most reputable, which had not been visited since 1904, were inspected, and only 2 were found deficient in sanitary conditions. Of the remaining 65, only 35 were up to the standard. Sixteen of these made necessary improvements under direction of the agent of the board, 4 abandoned their business in Brookline, 2 are now on probation, and the remaining 5, who failed to make the required improvements, were debarred from further business in the town. One considerable feature of the work has been the disinfection of over 1,000 milk jars taken from premises where contagious diseases were found.

During the year 751 samples of milk from 112 different dealers, besides samples sent to the office, have been examined as to milk solids. Of these, 53 were found below standard, and 48 notices of defect were sent out. As a rule, the milk quality has been well maintained. The use of milk preservatives has notably decreased.

Two hundred and sixteen samples of food other than milk have been chemically examined during the year.

Contagious Diseases affecting Food. — Much attention has been paid to the connection between the milk supply and the appearance of contagious diseases. In all suspicious cases the work has been prompt and thorough, and temporary suspension of employees of dairymen, and in some cases the quarantining of the milk supply, have followed every case where there appeared to be contact between the supply and a case of disease. The result of the year's work on this line justifies the conclusion that it should be extended as one of the best safeguards against the spread of contagious diseases.

In following out the work of watching the milk supply at premises when contagious diseases were reported, many omissions and infractions of the rules of the board of health were observed and corrected. Warning cards were not promptly posted in several cases, and the hanging of infected clothing on rear piazzas directly over the milk jars, after the presence of infection had been determined, was noted. In one case a warning card which should have been placed on the front door was found on the door of the sick-room upstairs, and the back door card was on an inner door leading from the entry into the kitchen. In this case it is clear that there was no proper warning at either entrance to the premises. These and similar occurrences emphasize the need of stricter enforcement of the quarantine laws.

In General. — In the municipal gymnasium, now being built on land adjoining the principal public playground and the public baths, the town will have still another means of promoting the physical, mental and moral welfare of its children and youth.

A number of the orders of the board have been amended the past year, and a few very important ones added.

CAMBRIDGE.

Medical Inspection. — Medical inspection of pupils in the schools has been continued along the lines followed since its establishment. Its usefulness would be much increased by the employment of nurses, who should visit the homes of the pupils and aid the parents by their instruction in carrying out the directions given by the school inspectors.

Clean Milk. — The movement which resulted in furnishing pure, clean milk for infants in Cambridge during the hot months of the past summer met with the active interest and co-operation of the board. In its opinion, much good was accomplished and a great deal of sickness and suffering among infants was prevented.

The board strongly recommends an appropriation for a continuation of the work during the coming summer. The work could with advantage well be begun earlier and continued a few weeks later than last season, and a sufficient appropriation should be made to enable that to be done.

Bacteriological Laboratory. — The total number of examinations made in the laboratory was almost ten thousand, as compared with about two thousand last year and three thousand the highest year previous, viz., 1900. The increase is due partly to two mild outbreaks of diphtheria, but mostly to the increasing use of the laboratory by physicians. A more general resort to laboratory tests for aid in the diagnosis of infectious diseases is gratifying from a public health point of view, but conditions are still far from satisfactory. A much more general use of laboratory aid in diagnosis would be desirable.

The Manufacture of Ice Cream. — Report has heretofore been made to the board of health in relation to the manufacture of ice cream by the larger concerns, and the board has caused notice to be sent to them of the requirements which must be carried out. Since this notice from the board, investigations show that all of the makers of ice cream in this city are preparing to begin the coming season in strict compliance with the regulations of the board.

Contagious Hospital. — The board again strongly recommends the immediate establishment of a contagious hospital in Cambridge.

CHICOPEE.

Medical Inspection. — A special appropriation for the cost of maintaining medical inspection in the public schools was voted by the city for the remainder of the fiscal year. For this work five physicians were appointed and assigned to their respective schools. These physicians were instructed to begin their inspections on October 16, each inspector to make one visit each week in the schools to which he was assigned.

CLINTON.

The past year has witnessed an awakening of a great interest in sanitation, and the sentiment that resulted in the pure food law is responsible for a great number of measures designed for the better protection of the public health.

Bakeries. — At a meeting of the board held in May it was decided to print rules and regulations in form suitable for posting in the bakeries of the town. A very general compliance with the law has been noted.

Milk Supply. — A general inspection has been made of all dairies in this town and vicinity, including all sources of supply. In cases where the owners of cow barns and dairies did not conform to the regulations of the board of health, notices were sent, informing them of the necessary changes required. A license and right to sell milk in Clinton may be forfeited by a wilful disregard of such instructions.

Barber Shops. — The rule applying to barber shops has been printed on cardboard hangers and distributed to the owners of each barber shop in town, to be conspicuously displayed therein.

Contagious Diseases. — The town has been fortunate during the past twelve months, in that it has not been visited by any epidemic of a contagious nature. The death-rate for the past year was 11.36, the lowest rate since statistics have been kept by the board.

During the past year the board has fitted up a building for use as an isolation hospital for the care of contagious diseases.

Rules and Regulations. — The board has adopted new rules and regulations, and two thousand copies have been printed and made up into neat little books for the convenience of the public. Several of the older rules have been modified to correspond with the wording of the latest health laws of the State. A copy of these rules and regulations has been sent to the physicians in town, and all others desiring copies can have them by calling at the office of the board.

EVERETT.

At the beginning of its term of office, the board, finding that there were practically no rules and regulations in force, drew up and adopted such rules as seemed best suited to its needs.

During the year the board has made strenuous efforts to have its milk supply produced under sanitary conditions. An inspection was made early in the year, and it was found that seven producers were not registered with the milk inspector, although some of them had produced milk for a number of years. The barns were often found to be in a filthy condition, and the drainage bad. While the conditions to-day in some cases are not ideal, there is a great improvement.

Tuberculosis has been placed in the contagious list, and a report is requested from all physicians in each case.

The board will hereafter maintain medical inspection in the schools, as required by statute.

GLOUCESTER.

During the past year the board has had several cases of diphtheria to cope with, and, while there has been no epidemic of the disease, the board believes that the number of cases would have been fewer had there been a contagious hospital to care for patients, and it urges a careful consideration of the needs of such a hospital.

Medical Inspection. — The board of health was authorized by the school board to take charge of the medical inspection of schools. Accordingly, the schools were divided into three districts and a medical inspector appointed for each district.

HAVERHILL.

Acting upon the advice of the city solicitor and upon that of the secretary of the State Board of Health, an effort will be made by the board of health of Haverhill to secure legislative enactment at the present session of the Legislature relative to the inspection of milk, and it is hoped that before the end of the year this work will be placed under the supervision of the board of health, which position, by legislative action, it occupies in many cities of the Commonwealth.

To carry into full effect the regulations of the board governing dairies and the sale of milk, made last year, an adequate appropriation for the salary of the inspector of milk, under the control of the board of health, is necessary; otherwise, these regulations cannot be made effective. But with efficient precaution at the dairies, a competent inspector to instruct and educate the men in the care of milk-producing cows, of utensils used in cooling products and of carrying and storing the milk, it is possible to reduce the number of bacteria to the minimum. A bacteriological laboratory is also needed.

The city council having placed at the disposal of the board funds to be used for bacteriological work in diphtheria, in March a bacteriologist was employed to make cultures for diagnosis and release. To meet the demands of the people, this work should be extended and enlarged to include sputa examinations for the bacilli of tuberculosis, for blood examinations for the Widal reaction of typhoid fever, and for the daily examination of milk.

Medical Inspection. — One of the most important items of progress during the year is the realization of a system of medical inspection of children, teachers and janitors in the public schools, and of the school buildings. For this work the board of health was, in August, directed to appoint two school physicians.

Sanitary Inspection. — Considerable time has been occupied in enforcing cleanliness and improving the sanitary condition of ice-cream factories, bakeries, "candy kitchens," etc. Some of them were exceedingly dirty, and the business was conducted in some instances without any regard whatever for cleanliness; others, located in dark cellars without adequate light, ventilation or drainage, were wholly unfit for the purpose of preparing human food. Improvements that were fairly satisfactory were made in some of these places, a few were closed, and to secure changes in four of them it was necessary to summon their proprietors into court, one of them a second time.

Notifiable Diseases. — In February tuberculosis was placed upon the list of "diseases dangerous to the public health," and physicians were notified to report cases coming under their notice.

Holyoke.

During the year it was found necessary to close two bakeries, as, in the opinion of the board, the sanitary conditions and general surroundings were of a character not conducive to good health. One of these bakeries has since complied with the requirements of the board, the other remaining closed.

Three general inspections of barber shops have been made, and in most cases they have been found to meet the requirements of the Board. Twenty-three warnings of minor offences were sent to owners of these shops. There exists a very general desire on the part of most barbers to comply with the regulation of the board, and the shops as a whole are conducted in a satisfactory manner.

Two thousand and seventy-one samples of milk were tested, and only forty-two warnings sent for having milk below the standard, and it was necessary to repeat the warnings in only a very few cases.

By order of the board, the license of one milk peddler was revoked for having a filthy wagon, and was renewed only when he presented a wagon that was in good condition. Several were warned for having swill in their wagons; the warnings did not have to be repeated.

The license of one store was revoked for being dirty, and was renewed when the place was put in a condition satisfactory to the board.

During the year two places used for the manufacture of ice cream were ordered closed, owing to their unsanitary condition.

The following recommendations were made by the board: the extension of the Walnut Street sewer to a point below the dam, and the elimination of all sewage from canals in their passage through the city; the establishment of a hospital for the care of contagious diseases, especially diphtheria and scarlet fever; improvements in the sanitary condition of Hillside Hospital, — in particular, a bath and disinfecting room and a proper disposal of sewage.

Hopedale.

At the March town meeting it was the expressed opinion that it would be desirable to have the board of health take up the mosquito question, and see what might be done to mitigate the nuisance.

It has been the aim of the board the past season to locate the breeding places and ascertain the best methods of getting rid of them. It was found that the principal large sources are along the course of the brook and pond, where marshy land is formed. A number of sources of very extensive and menacing character were also discovered on private property. Many of these breeding places have been improved, and at a very slight expense.

LAWRENCE.

The total number of contagious diseases has fallen off from 882 in 1905 to 755 in 1906, an actual decrease of 127; but, taking into account the large increase in population, the relative decrease is considerably greater.

About one-half as many cases of cerebro-spinal meningitis have appeared as in 1905. In only one month has there been any appearance of an epidemic, this being in March, when there were 12 cases; in no other month has the number exceeded 3.

Notwithstanding the large increase in population, the death-rate has not only decreased, but the actual number of deaths from all causes was 42 less in 1906 than in 1905. This is accounted for in two ways: first, the summer months were much more favorable to children than the preceding year, the weather being much less hot and sultry; and, second, the newcomers, being mostly working people, were mainly young or middle-aged people in good health when they came. These things, together with constantly improving sanitary conditions, have resulted in the continuation of the lowering of the death-rate.

The report of the plumbing inspector shows that there was a very great increase in the number of permits issued in 1906. The work includes fixtures for sinks, water-closets, bath tubs, set bowls, etc., and the total number installed was as follows: 1906, new buildings, 3,412; old buildings, 1,983. For 1905 the figures were, in new buildings, 2,088; in old buildings, 1,931. This increase is due in a great measure to the number of plumbing fixtures required in that mammoth plant, now practically completed, the Wood Mill, where 315 water-closets and 103 sinks have been installed. This, with the new work at the Arlington Mills, swells the total considerably. In this connection it is gratifying to note that the larger corporations are realizing the need of sufficient sanitary accommodations.

During the early part of the year the regulations of the board were carefully revised to meet the present conditions and requirements of the city, and, after having been submitted to the city solicitor for his inspection and approval, were published in accordance with law.

LEOMINSTER.

During the year the board of health has made valuable recommendations relative to quarantine, the collection of garbage, overcrowding of tenements, sewerage and the plumbing law.

Bakeries. — The various bakeries in town have been visited the past fall by the board. Lack of cleanliness was observed in nearly every case, both as regards the rooms and the utensils which were in use. Strict orders were given to put these places in a proper sanitary condition. In every case this request has been complied with.

Bacteriological Laboratory. — The work of the laboratory for the year has been greatly in excess of what was anticipated, due to the epidemic of diphtheria. Four hundred and forty-eight throat cultures have been examined.

The people are beginning to appreciate the great value this laboratory is to them. In the early recognition of certain diseases much time is saved, not only by the physician's being able earlier to make an accurate diagnosis, but also, in contagious diseases, in being able earlier to prevent the spread of the disease.

LYNN.

While the death-rate of 1905 at the contagious hospital was very low, the year past makes a still better record, as but 3 deaths occurred during the year. Of those who died, 2 had diphtheria and 1 had scarlet fever.

Medical inspection of the public schools has proved its value in the improved cleanliness of the pupils, and from the fact that several cases of diphtheria and scarlet fever have been found; also, many of the minor contagious diseases, such as whooping cough, mumps and chickenpox.

During the year the board has adopted regulations relative to the blowing or scattering of buffing or other dust or rubbish in the open air; the transporting of meat or poultry of any description through the public streets or ways of the city of Lynn; the sale of ice cream or any preparation similar thereto; and it has caused one hundred enamelled iron signs, with the spitting regulation printed thereon, to be posted in conspicuous places throughout the business section of the city.

MALDEN.

The board began the medical inspection of the public schools as an experimental measure, and the results were so satisfactory that the work has been continued, the board feeling confident that for the small amount expended the people were well paid.

NEW BEDFORD.

The board has just adopted regulations calculated to protect the milk consumers of New Bedford from impure milk. The regulations were made under the general law, and, if properly enforced, should greatly improve the quality of the milk sold in the city, and prevent the spread of infection through this medium. The more effectively to regulate and control the supply of milk, the inspector of milk should be an officer of the health department, and the board earnestly recommends that legislation be sought with that end in view. The inspector should be enabled to make frequent inspections of dairies, and should be qualified to make such chemical and biological tests as are necessary to determine the quality, purity and cleanliness of the city's milk supply.

The board also recommends that funds be furnished sufficient to establish in New Bedford some system for the distribution of milk for infants.

Tuberculosis Exhibit. — During the past summer the board made arrangements with the Boston Association for the Relief and Control of Tuberculosis for bringing the tuberculosis exhibit of that organization to New Bedford. A committee of the South Bristol District Medical Society took entire charge of the exhibit, attended to the details and defrayed the expenses. The chairman of the board of health was made a member of this committee.

NEWTON.

Medical Inspection. — During the four months that medical inspection in the public schools has been in force, it has proved its value.

Milk Farms. — In May the agent of the board visited all the milk farms within the city limits. In all cases where defects were found, the owners were notified by the board that they must make the necessary changes within a reasonable time, or discontinue selling milk. Subsequent inspection showed that the majority of the dairymen notified made the changes at once, and in only a few instances was any further action necessary. In no case was it found necessary to order a discontinuance of business.

NORTH ADAMS.

During the year there was an outbreak of diphtheria in the Blackinton School. This was readily controlled by appointing medical inspectors, who carried on the work until such time as the appropriation was exhausted. It is worthy of note, however, that the work of these inspectors extended over a period of a week, on request of the parents living in that district.

At an early period of the board's administration it caused to be brought to North Adams the Tuberculosis Exhibition. The result in every way justified the expenditure, and the presence of over a thousand adults during the four days of its continuance proves the keen interest which the people are taking in those things which concern the question of health and health measures.

The board recommends that the city take over the work of removing ashes and refuse, and it again calls attention to the need of further extension of its sewer system.

Bakery inspection was carried on during the year, as was the usual inspection of dairies.

Following up the work of last year, the board has caused to be distributed in the city reprints of Collier's articles exposing fraudulent medical concerns.

NORWOOD.

In 1905, by request of the school authorities, the board of health consented to make such medical inspection of the pupils of the public schools as might be deemed necessary. This work has been continued, and the results have proved satisfactory.

PITTSFIELD.

The board of health has made the following recommendations: that the city should seriously consider the establishment and maintenance of a hospital for contagious diseases; that the city should extend its sewer system north and northwest to Pontoosuc Mill and to Peck's Mills, as, with a properly installed sewer system, these manufacturing institutions could be compelled to dispose of a greater portion of their waste therein, and the pollution of the river could be correspondingly diminished.

The board would also recommend that, upon the expiration of the present contract, the city consider the disposal of house garbage by means of a plant established for burning waste, the power generated thereby to be used in supplying electric lights.

PLYMOUTH.

During the past year there have been but 33 cases of contagious diseases, the smallest number in the town of Plymouth for many years.

The board has adopted the policy of fumigating in all cases of contagious diseases, believing that it is far safer for the board to take charge of this work than to leave it to the discretion of individuals.

The regulations of the board passed during the year in regard to mufflers on motor boats have satisfactorily answered the purpose for which they were passed.

QUINCY.

Medical inspection of schools was begun in Quincy during the past year, and five physicians were appointed to carry on the work. These physicians have served without pay.

Bakeries. — A complaint was received from the State Board of Health in regard to the unsanitary condition of the bakeries in this city. After inspection, a notice was served upon all owners and tenants of bakeries to put their premises in a sanitary condition.

Recommendations. — The board recommends that a sufficient sum of money for a contagious disease hospital be appropriated, and that the necessary funds be provided to establish a bacteriological laboratory.

SOMERVILLE.

Two years ago the board made a request for an appropriation sufficient to enable it to build an incinerator on land near its stables. Recently such an appropriation has been made for that purpose, and an incinerator is now being constructed. When this is completed all the combustible refuse material can be burned, and a long-standing source of annoyance will be removed.

Isolation Hospital. — In 1905 an appropriation was made for a hospital for contagious diseases. The old building on the estate purchased was remodelled and necessary additions were made. The work was completed early this year, and the hospital was opened for patients on March 18.

The experimental stage of the hospital has passed, and the enterprise has proved a most gratifying success. Undoubtedly this institution has been a potent factor in preventing the development and spread of contagious diseases in the city. Many patients have been treated who could not have been properly isolated or cared for at home, and with additional accommodations and equipment the hospital will prove to be one of the most valuable additions to the institutions of the city.

Medical Inspection. — In November money was appropriated for the purpose of instituting medical inspection in the schools of Somerville. The board of health, with an advisory committee of the school board, arranged a system of inspection, which was put in operation early in December. Inspectors were appointed, circulars describing the system were sent to parents and physicians, and a mass meeting of teachers was held, at which the plan was described in detail.

SPRINGFIELD.

The board of health recommends that, in addition to the tests to determine whether the milk is of legal standard or not, a limit should be placed upon the number of bacteria which milk can legally contain, and for this reason it is of the opinion that the bacteriological examination of milk should be undertaken. In addition to this examination of milk, the board believes that further attention should be paid to the determination of the temperature of the milk.

The board has ruled that stables for cows as well as for horses must be licensed, and during the past year the occupants of several unsanitary cow stables have been obliged to remove from their locations because of failure to secure a license.

Medical Inspection. — A small appropriation was obtained last year to inaugurate a system of medical inspection of the public schools. As the sum was not considered large enough to carry on the work for a full year, it was decided to begin this work at the opening of the school year in September. During the summer a set of rules governing medical inspection of the schools was devised by the board of health and submitted to the school committee for its approval. These rules were adopted both by the school board and the board of health, and the work was undertaken under the supervision of the board of health last September. It was decided to appoint ten physicians as medical inspectors, and to appoint a specialist in the diseases of the skin and nervous system as consulting physician, to serve without pay.

The city was divided into ten school districts, and the apportionment was so made that each inspector had about 1,200 children in his district. Two inspections are now made each week, and reports of all examinations are made to the board. A school record of these cases is also kept.

The record of the four months' work amply demonstrates both the need and usefulness of routine medical inspection of public school children.

Isolation Hospital. — The capacity of the isolation hospital has been taxed to its utmost during the past year, and the time has come when it no longer is able to care for the patients in a proper and efficient manner.

The board recommends that additions and improvements be made, taking in the almshouse hospital building, and including a new equipment for proper laundry and kitchen facilities. The board strongly urges, also, that in connection with the laundry department of the isolation hospital there be built a steam disinfecting plant, such as the Worcester and Brookline and many other isolation hospitals maintain.

Bacteriological Laboratory. — The work of the bacteriologist continues to increase year by year, and the actual number of tests made during the past year is nearly 25 per cent. more than during 1905. In the latter part of 1905 the board of health decided to include among the free laboratory tests examinations of blood in cases of suspected typhoid fever, so that the work of the bacteriologist now consists in the examination of sputa in cases of suspected tuberculosis, cultures for diagnosis and release in real and suspected cases of diphtheria and tests of blood in doubtful cases of typhoid.

STONEHAM.

Owing to complaints which were made to the board of health, rules for the regulation of barber shops were adopted Sept. 28, 1906, printed, framed, and put in every barber shop in Stoneham. These rules seem to be giving general satisfaction.

TAUNTON.

The board of health proposes to cause to be made during the coming year a thorough examination of the premises of every licensed milk dealer within the confines of the city, and to inform itself, and then the public, as to whether or not the premises of those dealers are in a sanitary condition; if the barns, sheds, working tools, etc., appertaining to such establishments are in proper condition; if the proper precautions in the way of cleanliness are observed by the working forces of milkers and others handling the milk; if the cows are properly cleansed before being milked; and if the milk is properly cooled and stored prior to delivery.

Bakeries. — The board has visited the different bakeshops in the city, and most of them were found in a fairly satisfactory condition. Two were found in excellent condition, while, on the other hand, two were found to be extremely dirty and in need of a general cleaning.

Following the usual custom, the board has again caused copies of the State law governing bakeries to be posted in every bakeshop. The law demands this, and such posting takes from the proprietor the opportunity of pleading ignorance of the law.

Barber Shops. — The board has made and published rules for barber shops, and it proposes to have a copy placed in every shop.

Tuberculosis. — A regulation requiring physicians and others to report to the board of health cases of tuberculosis coming within their knowledge was approved and published at the time of the revision of its rules and regulations.

In January the members of the board attended the Tuberculosis Exhibition in Boston. Arrangements have since been made for holding a similar exhibition in Taunton, and in this the board will have the co-operation and assistance of the other physicians of the city and surrounding towns, as well as of other interested citizens.

The board has revised its rules and regulations during the year, keeping the best of the old rules and adding the best of the rules of other cities.

WALTHAM.

An epidemic of diphtheria which began the latter part of August reached its height about the middle of October, then gradually declined. Owing to the fact that the cases occurring during August and September were of a very mild type, the outbreak was difficult to suppress, as in many instances no physician was called until several members of the household had become ill. In September it was decided best to inaugurate a system of daily inspection and examination of all persons known to have been exposed to the disease. A physician was employed whose special duty was to visit each house where diphtheria had broken out or where those known to have been exposed were living, and make an examination of the members of the household. This practice was continued in each instance during the incubation period of two weeks, and had the effect of preventing a greater spread of the disease, as several cases were discovered in the very early stages and promptly isolated, either at their homes or in the hospital.

Pulmonary tuberculosis has been added to the list of diseases required to be reported to this board, and the board is about to prepare a circular letter containing advice and instructions to persons afflicted and to those coming in contact with tuberculosis.

The board, in its effort to improve the sanitary conditions surrounding the production and distribution of the milk supply, has been assisted by the State Board of Health, that Board having caused one of its inspectors to visit and examine the premises of the producers. A statement of the conditions as found and reported by the inspector, together with the recommendations for improving those conditions, was furnished this board, which then caused copies of the reports to be sent to the producers, notifying them that a strict compliance with the terms of the notice must be observed. Subsequent inspection of the dairy farms was made by the agent of the board, who reported a general compliance with the orders issued.

The regulation of the board relative to keeping fowl has been so amended as to prohibit their being kept in any part of the city until a license shall have been obtained from the board of health.

WATERTOWN.

During the past year the general health of the community has been remarkably good, and the death-rate, as will appear from the report of the agent of the board of health, is lower than in previous years. The board has been exceptionally fortunate in that it has not been called upon to deal with any possibility of epidemics of communicable diseases;

and it believes that this improved condition is due to the rigid medical inspection of schools, the proper medical treatment of those exposed to contagion, the thorough fumigation of the schools and houses whenever a case of contagious disease was found, and the energy and ability of the agent of the board to handle such cases.

The work of exterminating mosquitoes was done under the direction of the agent of the board, and the board feels that the work amply justified the expense, from the fact that the town has had almost a complete immunity from malaria.

WESTFIELD.

After a conference with several of the leading grocers and provision dealers, and backed by a strong public sentiment, the board decided to institute on a small scale a pure food campaign. The housekeepers of Westfield wished to know what they were buying, and the majority of grocers were equally anxious to know what they were selling. Only one dealer has made any objection to this investigation. Three hundred and two samples of food and beverages, exclusive of milk, were collected and caused to be analyzed.

Through the co-operation of the merchants, the board has at its rooms a collection of 184 samples of adulterated food and medicine. The exhibit is unique, and, so far as can be learned, no other town in the United States has a similar display. The collection is frequently consulted by grocers previous to the purchase of new goods, and by many others interested.

The board has tested 52 samples of kerosene oil from tank cars, tanks, wagons and stores. This work was begun in May, 1906, and since that time the board has been obliged several times to notify the producers that oil offered for sale in Westfield must be up to the standard. The request has invariably been complied with at once.

The milk dealers of Westfield have been requested to adopt a style of dress for selling milk that shall be of a color that will easily show whether or not they are clean, these suits to be worn only while delivering milk. Some dealers have complied with the request.

At a meeting of the board it was voted that regulations respecting the production, care and sale of milk be adopted. It was also voted that pulmonary tuberculosis is a disease dangerous to the public health, and must be reported to the board, as required by law.

WHITMAN.

Early in the spring the board voted to inspect all dairies, cows, stables, barns, water supplies and utensils of all kinds used when the milk therefrom was to be delivered in the town of Whitman. In carrying out that ordinance, the board inspected 31 dairies, in all 340 cows, and gave suggestions when, in its opinion, improvements could be made in regard to cleanliness, ventilation, and the cooling of the milk. The bacteriologist was employed to gather samples of milk as it was being delivered through town from the carts; 60 samples were taken in all. A copy of the result of the examination was sent to the milkmen, with the request that they co-operate with the board in its work. Before the work of taking samples was finished, the number of bacteria per cubic centimeter began to decrease, and at last was within the limit as set in the "Rules and Regulations for the Production, Care and Sale of Milk in the Town of Whitman."

WINCHENDON.

The introduction of town water and the improved condition of the milk supply have almost eliminated typhoid fever from the community, the number of cases having been reduced to 3 or 4 a year, where there were formerly 20 to 30.

The amount of disease among young children during the late summer and fall has been very much lessened, principally by reason of the clean barns and care taken with the milk.

The board of health recommends that under no circumstances should ice for domestic purposes be taken from Miller's River.

WORCESTER.

Bacteriological Department. — This has been the busiest year in the history of this department, owing to the outbreak of diphtheria and the work of the medical examiner of schools. As many as 70 cultures were frequently examined daily. In all, 5,148 cultures were examined, and of these 2,821 were primary cultures, 758 being positive and 2,063 negative. The balance were release cultures, — 2,327 in number.

Four hundred and sixty-eight specimens of sputa were examined; 149 were positive, 293 were negative and 26 were poor specimens.

Diphtheria. — More cases of diphtheria were reported this year than in any year of record. The outbreak began in August, with 60 cases reported, and reached its height in October, with 200 cases reported. In all, during the year, 759 cases were reported, with 48 deaths, — a mortality of 6.33.

This outbreak has convinced the board of the imperative need of greater hospital accommodations, for which it has been asking for the past six years. The board is firmly of the opinion that if it had had adequate room at the isolation hospital, it could have materially diminished, if it could not have entirely checked, the spread of diphtheria. While the board is clothed with ample power to move to the hospital, without consent of the parents, any patient sick with these acute infectious diseases, it could not use that power because it had not the room to care for them.

Medical Inspection. — During the year an appropriation was made for medical inspection in the schools. As soon as the appropriation was available, the board appointed fifteen physicians for the work. These inspectors began their duties on October 8, and rendered great assistance in preventing the spread of diphtheria among the pupils of the schools. No less than 31 cases were discovered in the first three months and excluded from the schools. All of these were what is known as bacteriological or walking cases. These, with the other cases of acute infectious diseases found and excluded, would more than justify the small amount of money expended; but when is added to these the large number of other diseases found, it will be seen what a necessity this most important work is.

Bath Houses. — The past summer has again forcibly demonstrated the necessity of an enlargement of the city's bath houses, or the erection of new ones. Owing to the limited accommodations, it has not been possible at times during the season to care for all who wanted to enjoy the refreshment of a bath in the open water of the lake. As the city grows, it is inevitable that the lake will be visited by increasing numbers, and some provision should be made at once for additional space.

The board also recommends that a new bath house be provided for women and girls, in order that adults may have a place separate from the younger children.

Bakeries. — It is the purpose of the board to adopt, in the near future, rules under chapter 75 of the Revised Laws relative to the inspection of bakeries, in order that the products of these places may be made and sold under the best possible sanitary conditions. Fifty bakeries were visited during the past year.

Milk Inspection. — In the closing days of the session, permission was obtained from the Legislature to transfer the inspection of milk to the board of health. In July the final transfer was made, and the board, with the consent and approval of the Civil Service Commission, reappointed the inspector already in charge of the work. The first duty assigned to him was to make a personal inspection of all the dairies that supply the city with milk. Wherever the conditions were found to be unsanitary, the owner's attention was called to the matter and he was requested to remedy the same.

It is also the intention of the board to examine the milk bacteriologically as soon as the necessary apparatus can be obtained, and at an early date to adopt rules regulating the production and distribution of the supply.

The Manufacture of Ice Cream. — During the months of August and September 57 visits were made to places where ice cream was made and sold. The places where ice cream for street vendors was made and handled were not, in the opinion of the inspector, clean, and no precautions were taken in regard to sanitary conditions. Their product is sold mostly to children. The other places visited were generally in a good condition, and the suggestions made were promptly complied with.

Slaughterhouses. — The licensed slaughterhouses were visited early in the year, and numerous changes in the interest of cleanliness were ordered. These changes have been made, and the local places are now in good sanitary condition.

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